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ABSTRACT

This book is one in a series of teacher resource books developed to: (1) rescue students from the clutches of computers that drill and control; and (2) supply teachers with computer activities compatible with a mathematics program that emphasizes investigation, problem solving, creativity, and hypothesis making and testing. This is not a book about Logo, but about mathematics and thinking mathematically. Many chapters require no Logo skills. Each chapter may include as many as seven sections: summary box, getting started, instructions, examples, activities, key summary, and worksheets and includes appropriate grade-level designations. The chapters in this book are: (1) Stamp Designs, (2) Designs from Color Patterns, (3) Sticker Designs, (4) Circular Fraction Paths, (5) Design Master, (6) Tartan Design, (7) Making Tracks, (8) Instant Logo, (9) Lotsalists, (10) Fractal Designs, (11) Translation Designs, and (12) Designs from Overlapping Arrays. Appendices include a summary of LogoWriter keys (Apple IIe/IIc, IBM, and Macintosh), a quick reference (LogoWriter Primitives and Special Words), and additional primitives for the Macintosh. (MKR)

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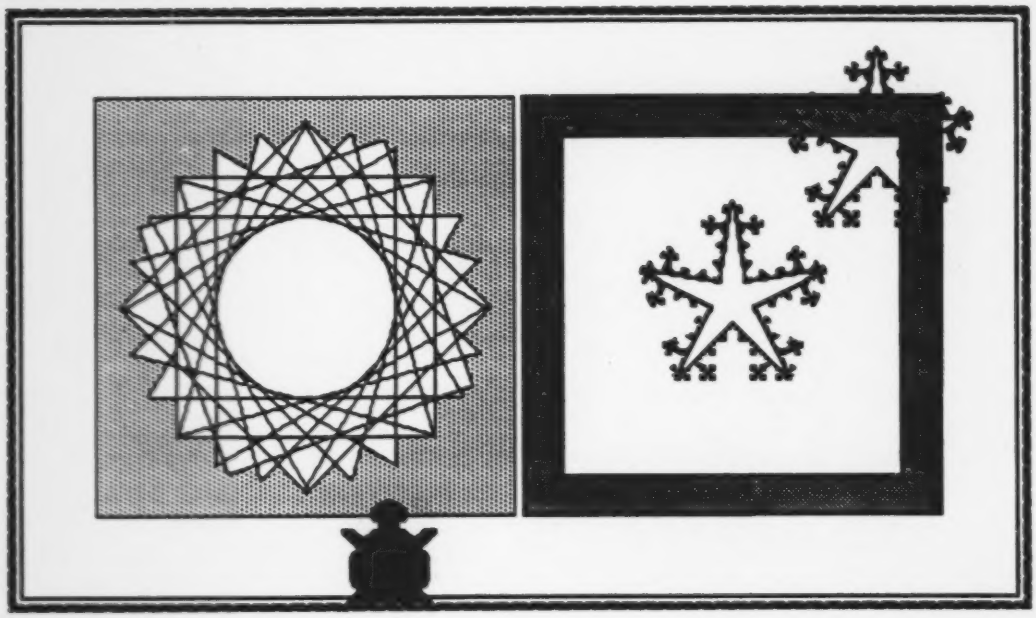
ED 372 922

Math Activities Using *LogoWriter*

Patterns and Designs



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About the Author

Gary Flewelling received his B.Sc. from the University of Windsor, Windsor, Ontario, Canada, and his M.M. (Master of Mathematics) from the University of Waterloo, Waterloo, Ontario, Canada. He has been a teacher since 1964 and a mathematics consultant for the past 13 years.

His main interests in mathematics education are natural learning and the integration of technology in the math classroom. He developed—and is still developing—*Math Activities Using LogoWriter* products and books out of a belief that computers should be used more effectively in the math classroom and that Logo should be tied more closely to the math curriculum.

Gary lives with his wife Barb in the small rural Ontario village of Arthur and spends most summers camping and rockhounding in Australia.

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Math Activities Using *LogoWriter*

Patterns and Designs

Gary Flewelling

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From the Publisher

The purchaser of the *Math Activities Using LogoWriter—Patterns and Designs* package receives this book, a data disk, and a single-user site license. The *LogoWriter* application is *not* included and *is* necessary for using the disk files.

The single-user site license gives the one person who is designated as the "primary user" of the package the right to make copies of worksheets, disk files, and other material necessary for use in his or her classroom; this right does not transfer to class participants. If the single-user site license is purchased by a school or school district, the intent is that one person be designated as the primary user. If several teachers will use the book, separate packages must be purchased for each individual teacher.

Acknowledgments

For my best friend, my wife Barb.

Thanks also go to Bill Higginson, Queen's University, Kingston, Ontario, for his ongoing support of this project; Dan Hawkins, for translating and enhancing an earlier C64 version of a number of chapters; and to Doug Benstead for helping to "spread the word" at many computer courses and workshops.

G.F.

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Preface

A working group of the Canadian Mathematics Educators Study Group (CMESG) met on the campus of the University of Waterloo in June of 1984 to discuss the issue of using Logo in schools. After three days, the group concluded that:

1. Logo, not linked strongly to existing school programs, runs the risk of becoming trivialized.
2. Logo deserves to be integrated into school math programs.
3. Logo is a tool that can be used by teachers to help them implement their mathematics curriculum.
4. Teachers need proof of items 2 and 3.
5. Proof is needed in the form of student activities illustrating items 2 and 3.
6. Samples of activities referred to in item 5 need to be developed and delivered to teachers.

The group agreed that the activities referred to in items 5 and 6 should possess many of the following characteristics.

- can be used by students with a variety of interests and abilities
- allow for a number of lines of inquiry
- can be returned to again and again throughout the school year
- can be used through the grades at varying levels of sophistication
- have links to the mathematics curriculum

- contain an element of choice/freedom/modifiability for both the teacher and the student
- may require the student to construct various procedures to carry out related investigations
- may have to be accompanied by pre-written procedures
- invite the cooperative effort of more than one participant

The conclusions and criteria listed above have guided the author throughout the development of this project.

This series of teacher resource books has been developed to meet two needs. The first, to rescue students from the clutches of computers that drill and control. The second, to supply teachers with computer activities compatible with a mathematics program that emphasizes investigation, problem solving, creativity, hypothesis making, and hypotheses testing.

It is the author's intent that the teacher review and select an appropriate chapter or set of activities within a chapter and integrate them into his or her mathematics program.

Some teachers will want to introduce the whole class to an activity. Others will want to introduce the activity to a smaller group of students who will then act as an expert group for the rest of the class. Still others will simply hand over a copy of the chapter to some students and challenge them to discover something interesting that they can share with others. Some teachers will have a student choose an activity of interest and allow the student to pursue it independently.

In all of these scenarios the teacher will act as a facilitator of the activity, encouraging students to reflect on their work, make and test conjectures, share and discuss findings and problems with other students, ask and investigate "what if" questions, evaluate and refine their own and other students' work, and do some follow-up study. Students can then report their findings in a variety of ways, for example, as a written

report, an oral report to a small group of classmates, a poster or similar display, or a set of conclusions summarized in their journal.

Introduction

This is not a book about Logo; it is a book about math and thinking mathematically. Many chapters require no Logo skills. Where Logo skills are required, they are identified. The basic Logo primitives are described in the appendix at the end of this book. This document does not teach advanced Logo programming skills. See your Logo manual for such details.

Chapter Organization

Each chapter may include as many as seven sections: summary box, getting started, instructions, examples, activities, key summary, and worksheets.

Summary Box

The summary box at the beginning of each chapter includes information about files containing accompanying procedures, appropriate grade levels, color recommendations, and exceptions regarding platform availability. Also included is an illustration of one possible pattern or design.

File Names

Most chapters are accompanied by a group of pre-written *LogoWriter* (TM by LCSI) procedures included in the file named in the summary box.

Grade Level

Many chapters in this book can be used at a variety of levels of sophistication and are identified as multigrade:

P indicates Grades 1-3

J indicates Grades 4-6

I indicates Grades 7-10

S indicates Grades 11-12

Color

Many of the programs used in this book include color. The number of colors available depends on the kind of computer you are using. In general, there are 6 colors on the Apple II, and 3 pen colors for the DOS version; the colors are limited to 15 on the Macintosh.

With a monochrome monitor, the color will alternate between black and white. In general, this will make the turtle alternate between being visible and invisible. If you can't find the turtle, press the key for pen color—usually I = Ink.

Software/Hardware

This book can be used with versions of *LogoWriter* 2.0 or above. Data disks to accompany it are available for the Apple, MS-DOS, or Macintosh platforms. Some programs are not available in all platforms; exceptions are noted in the summary box.

Getting Started

The directions in the Getting Started section of each chapter tell you how to begin using the program for that chapter.

Instructions

Most chapters include an Instructions section. In general, this section describes the details of how the program keys work. Sometimes this section includes an example, particularly when the function of the program is quite complex.

If the chapter is accompanied by pre-written procedures, instructions for using the procedures are given.

Examples

Some chapters have a number of examples that are included to show the teacher or students what the program can

create. Studying these examples will often help them understand how the program functions.

Activities

A series of suggested activities generally accompanies each chapter. Each teacher must judge the appropriateness of any activity for a particular student. Many activities progress better with two students working together.

Teachers are encouraged to take the initiative and modify activities as needed and create new activities as appropriate. They should preview each chapter before giving it to their students.

Key Summary

Most chapters include a key summary at the end. This chart can be copied and kept near the computers where students are working. Details of the key functions are *not* included here.

Worksheets

Some chapters include worksheets. Their purpose is outlined in the appropriate suggested activities.

Tips for Using These Programs

Before You Begin

Make a copy of the disk that came with this book. Store the original in a safe place.

Start *LogoWriter* in the usual manner. If the chapter requires use of a set of pre-written procedures, locate the appropriate file name on the copy of the disk that came with this book. Load the file into *LogoWriter*.

Be sure that the Shapes page that comes with the data disk is also on the disk containing the LogoWriter *files.*

Space

After working with some programs for a length of time, you could get an "out of space" message. If that happens, generally you can start the program again by typing START in the Command Center and pressing Return/Enter.

Interrupting a Program

At any time you may interrupt a program that is running by pressing the stop key (Command-. on the Mac; Ctrl-Break for Dos; Apple-S for Apple).

Working With Pictures

Students often will want to save designs that they have made. The following procedure will work for most of the programs in this book. Notes about working with retrieved pictures for particular programs are found in the individual chapters.

To Save a Picture

1. The program should not be running; if necessary, press the Q key or the stop key to exit. You need to be able to enter commands directly in the Command Center.
2. Type SETDISK "A and press Return/Enter.
3. Insert a disk in the A or first drive.
4. Type SAVEPIC *"name of picture"* and press Return/Enter.

To Retrieve a Picture

1. The program should not be running; if necessary, press the Q key or the stop key to exit. You need to be able to enter commands directly in the Command Center.
2. Type SETDISK "A and press Return/Enter.
3. Insert a disk in the A or first drive.
4. Type LOADPIC *"name of picture"* and press Return/Enter.

Printing

Printing the Page

Some of the programs that come with this book include single-keystroke commands for printing the page. If there are no built-in commands for printing, you can exit the program and type

```
PRINTSCREEN
```

to transfer the graphics and text on the page to paper.

Printing Procedures

If you want a copy of the procedures for any particular program, you can flip the page, move the cursor to the Command Center (use the down key), and type

```
PRINTTEXT
```

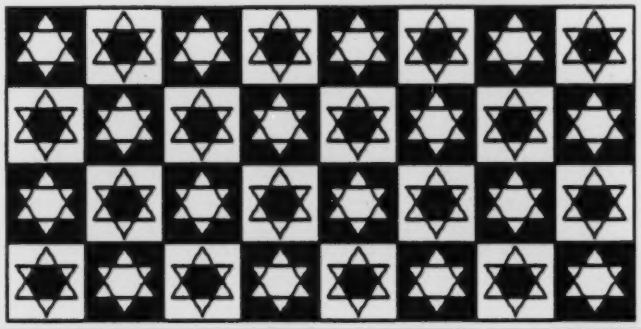
The procedures will appear on paper the same way that they appear on the screen.

Note that the code for all of the files is not documented and in general should not be provided to students.

Chapter 1. Stamp Designs

Summary

Filename: STAMPPAD
Grade Level: P/J/I
Color: Optional
Not available for the Apple



STAMPPAD gives users an electronic set of rubber stamps and a set of stamp operations with which they can create a variety of geometric designs. The designs can be changed by selecting different stamps, inks, inking instructions, stamp positions, and orientations; overstriking stamps; changing stamp sizes; changing grid dimensions; and adding and deleting supplementary lines and colors.

Getting Started

1. Get the page STAMPPAD.
2. Type START and press Return/Enter.
3. The stamps are used within a grid of squares. The number of squares in one column of the grid and the number of columns in the grid are defined by the user. These numbers can range from 1x1 (a single square) to

20x20. The stamps are automatically scaled to fit within the dimensions of squares comprising the selected grid.

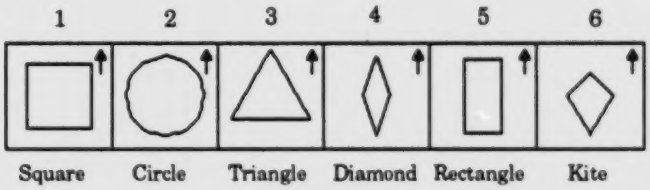
Enter the number of squares in one column and the number of columns in the grid. (The grid of stars above has four squares in a column and eight columns of squares.)

4. A ">" prompt appears. Use the following keys to create designs.

Instructions

The Stamps (Number Keys)

The stamps are numbered 1 to 6.



An imprint of the stamp is made, within the indicated grid square, by pressing the appropriate number key. The imprint is centered on the cursor.

Drawing the Grid (G Key)

Press the G key to draw the grid. Make sure that the pen state (S key) is set to Pen Down (PD). You can erase the grid when the pen state is set to Pen Erase (PE). You can change the color of the grid by using the I key to cycle through the colors.

Moving Through the Grid (Arrow Keys)

Use the arrow keys to move to different squares within the grid. The mouse is disabled. On the Macintosh, moving the mouse causes the "watch" cursor to be displayed, but the mouse is not active.

Clearing the Display (K Key)

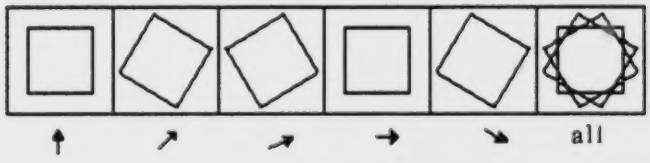
To clear all designs but not the grid, press the K key.

Defining a Turning Angle (T Key) or Turning a Stamp (< > Keys)

Press the T key and type a number of degrees to define a new turning angle. Thereafter, each time the < key or > key is pressed, the stamp is turned counterclockwise (<) or clockwise (>) the number of degrees you have specified.

Though any turning angle can be defined, it is wise to enter some divisor of 360°. For example, 180°, 120°, 90°, 72°, 60°, 45°, 30°, 15°, or 0° would be good choices.

If 30° is entered, then each time the > key is pressed, the shape drawn will be rotated 30° as shown in the following illustration. The last square shows all of the previous squares superimposed on each other.



The cumulative effect of using the turn keys is displayed as a direction arrow shown in the upper right corner of the page.

A 180° turn effectively lets the user use a stamp upright or upside down. A 90° turn lets the user make quarter turns left or right before making a stamp imprint. A 0° turn disables the turn keys.

Erasing a Stamp Imprint (S Key)

Press the S key (pen state). When the pen state is PE, the imprint of the selected stamp will be erased from the square (provided that the original and erasing stamps are alike in number, size, position, orientation, and O-mode; see the following instructions) and drawn in the occupied square. Remember to put pen state back to PD to make further stamp imprints. If the pen state is Pen Up (PU), the turtle can be moved without leaving a trail.

Be careful when erasing negative imprints. You will erase more than you bargained for if the region to be deleted is in

direct contact with other regions or lines of identical color (in such cases, one strategy is to redraw the grid in a contrasting color before erasing the imprint).

To erase all traces of a stamp with PE, you may need to change the orientation of the stamp and repeat several times.

Selecting an Ink Color (I Key)

Pressing the I key will let the user select a color to draw in, indicated by the color of the "+" cursor. Repeatedly pressing the I key cycles through a number of colors. The particular number of colors depends on the version of *LogoWriter* you are using.

Note, if you are using a monochrome monitor, be sure that the + cursor is visible. If it disappears, then you may be drawing in the background color, and you will not be able to see anything that you draw.

Inking Instructions (O Key)

Each stamp can draw its imprint in one of three modes,

Hollow, the shape in outline

Solid, the interior in solid color

Negative, the exterior in solid color

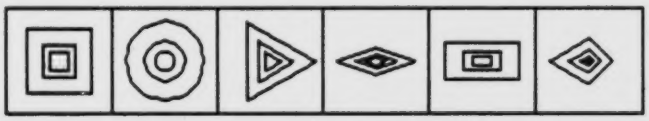
The user can cycle through these three choices by pressing the O key (stamp output mode).

Be careful when erasing negative shapes. The grid may be erased as well. See the preceding section on erasing.

Selecting Stamp Size (- Key)

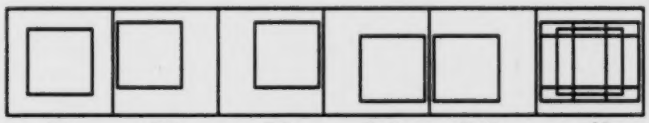
The stamps are automatically scaled to fit into the squares of the selected grid. Within each square, the user can make full-, half-, and quarter-size imprints within the square.

The user can cycle through these three choices by pressing the minus key (-).



Changing the Position of Stamps Within a Square (U, D, R, and L Keys)

The U (up), D (down), R (right), and L (left) keys are used to move the imprint of a stamp within a square. The coordinates for the location of the shape show in the state line of the Command Center. The center of the square is designated 0,0.



Printing the Design (P Key)

Press the P key and respond Y (yes) to print the design. Press N (no) if you change your mind.

Quitting the Program (Q Key)

To stop the STAMPPAD program, press the Q key. To restart the program type START. This is a convenient method for starting over with a different grid size.

Using Design Master Features

Users also may apply all of the features from Chapter 5, Design Master, when creating stamp designs.

Especially useful features include

- filling and unfilling regions
- defining new brush instructions
- using the M key

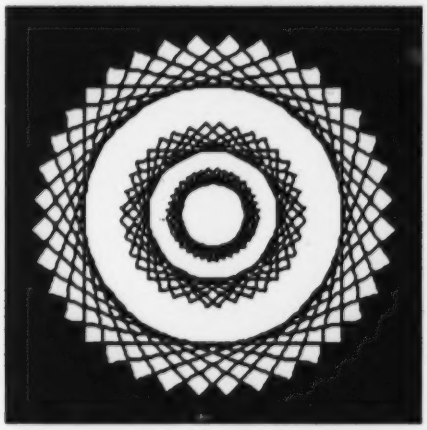
Activities

Activity 1: Free Exploration

Get used to using the various features of STAMPPAD.

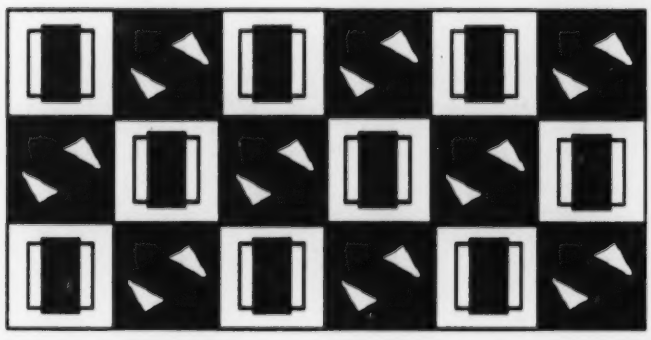
Activity 2: Designs In a Single Square

Create a stamp design in a single-square grid.



Activity 3: Stamp Designs

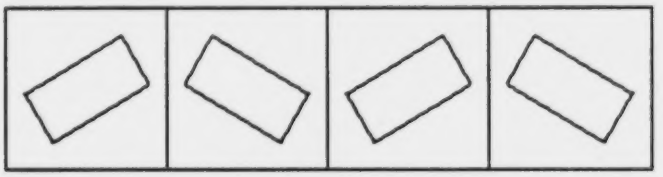
Create your own stamp designs. Print one of them and explain to a classmate how you created it.



Activity 4: Concentration

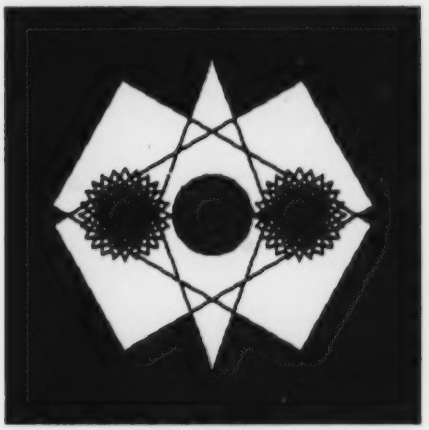
Give some of your classmates a print of a simple design on a strip grid or small rectangular grid. Let them study it for a

short, measured amount of time. Then have them try to recreate it from memory on their monitors.



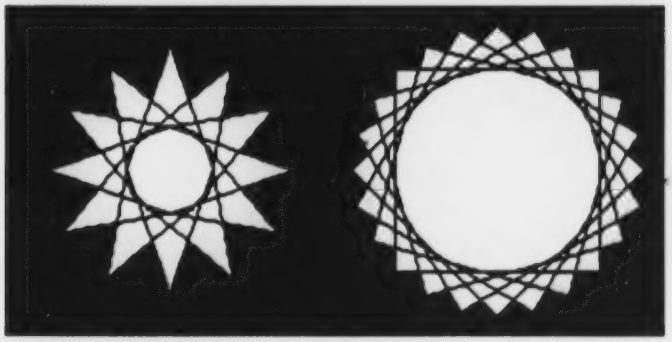
Activity 5: Analyzing a Design

Give some of your classmates a print of one of your single-square designs—from Activity 2—to study and work from. Let them try to reproduce it on their monitor.



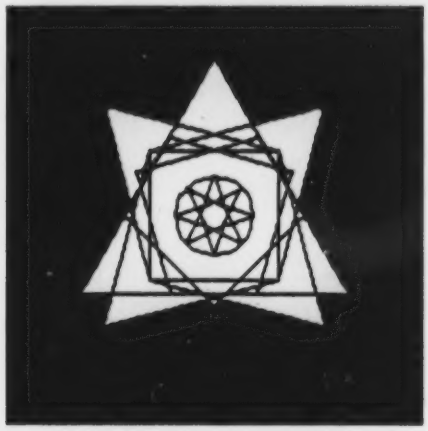
Activity 6: Paired Designs

Work in pairs. Select a 1x2 grid. Person 1 builds a stamp design a few steps at a time. Person 2 repeats these steps using a different set of stamps, for example, every time person 1 uses Stamp 1 (hollow), person 2 might use Stamp 2 (solid). Compare the finished designs. In what ways are they the same? In what ways are they different?

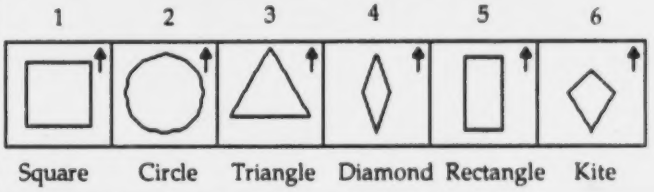


Activity 7: Art Project

Use the STAMPPAD program to make experimental designs. Select one of your designs to help you design a large handmade piece of art.



Key Summary for STAMPPAD

Numbers 1–6	Imprint the following stamp shapes  Square Circle Triangle Diamond Rectangle Kite
G	Draws the grid (erase with PE; draw with PD; color with I key)
Arrow keys	Move the cursor to desired square
K	Clears all designs but not the grid
T	Defines a turning angle; enter a number of degrees and press Return/Enter
< >	Turn stamp counterclockwise (<) or clockwise (>) at a fixed angle
S	Toggles between Pen Down (PD) and Pen Erase (PE)
I	Selects a color to draw in; press repeatedly to cycle through the available pen colors
O	Selects the output mode: hollow, solid, or negative
-	Selects stamp size: full, half, and quarter
U L R D	Change the position of a stamp in a square
P	Prints the design
Q	Quits the program (Type START to begin again.)

(See Chapter 5, Design Master, for other key features.)

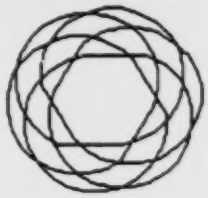
Chapter 2. Designs from Color Patterns

Summary

Filename: COLORS
Grade Level: P/J/I
Color: Recommended

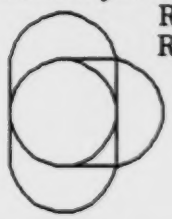
Color keys:
ARRLARRL. . .

Color keys:
RRRATRRRAT. . .



Color keys:
ARTTARTT. . .

Color keys: ARRARR,
RRARRA,
RARRAR



Using COLORS, students can create designs with a series of keystrokes. Each piece of the design corresponds to a color. Thus, a complete design corresponds to a sequence of colors.

Getting Started

1. Get the page COLORS.

2. Type START and press Return/Enter.
3. You see a > prompt. You are now ready to begin creating a design using the following instructions.

Instructions

Drawing Keys (A, R, L , Z, and T Keys)

The A key draws a straight-line segment in the direction the turtle is facing.

The R key draws one-fourth of a circle to the right and the L key draws one-fourth of a circle to the left.

A colored rectangle appears on the upper left side of the page each time you use a key. For each key, a different colored rectangle appears. These blocks are useful in determining the pattern used.

The Z key moves the turtle forward in the direction it is facing without drawing a line, and puts a hollow rectangle on the upper left side of the page.

The T key turns the turtle 30° clockwise and puts a hollow rectangle on the upper left side of the page.

The color names differ depending on the computer system you use. Enter the names of the colors for your particular computer system in the chart at the end of the chapter. It may be helpful to put colored stickers on the keys used for this activity. The turtle will *not* draw in color, however.

Note that the row of colored rectangles begins at the left side of the page and grows to the right. If you are using a monochrome monitor, the blocks in the upper left corner of your page will not be helpful in determining the pattern you used.

Changing the Size (S Key)

First, draw a design. To redraw your design larger or smaller, press the S key. You are asked for a size. Enter a

number and press Return/Enter. The original design disappears and is redrawn in the new size.

- Numbers <1 make smaller designs (e.g., 0.2, 0.7)
- 1 makes the design the original size
- Numbers >1 make larger designs

Below are examples of the same design drawn in three different sizes. When a design is redrawn in a new size, the colored blocks at the top left of the page disappear.

0.5 1.0 2.0

The S command will redraw all parts of the graphic in the specified size. In other words, if one design has been drawn at size 1, a second one drawn at size 3, and then size 2 is selected, both graphics will be redrawn at size 2.

Note that the erase feature described later works only when the parts of the design being erased are in the original design size.

Clearing the Page (K Key)

Pressing the K key removes the graphics from the page.

Erasing (- Key)

When you press the - key, the last line drawn is erased. In addition, the last color block is erased. Repeatedly pressing the - key erases the commands that make the design on the page, one at a time.

You may find that the - key does not completely remove lines that have been previously drawn. This depends on the type of computer that you are using.

The - key does not work when the size of the original design has been changed. If you need to erase part of a design after changing its size, first use the S key to change the size of a design back to 1 and, modify the design and then change the design back to a different size.

New Row (N Key)

If your design involves many drawing keys, you may find that your row of colored blocks has wrapped around and threatens to overlap the original row. Use the N key to start a new row of colored blocks. Each time you press the N key, a new row of blocks is started below the row already on the page.

Quitting the Program (Q Key)

To leave the COLORS program, press the Q key. To restart, type START.

Activities

Activity 1: Free Exploration

Spend some time exploring the commands available in the COLOR program.

Activity 2: Matching a Color Pattern

With color patterns on paper strips provided, re-create and extend the patterns, both on and off the computer. Use the worksheets at the end of this chapter.

Activity 3: Color Patterns and Geometric Designs

Create color patterns that give interesting geometric designs. Then create a paper strip copy and give it to another student to create and extend on the computer.

Activity 4: Color Arrays

Repeat Activities 2 and 3 using the N key to make more than one row of colors.

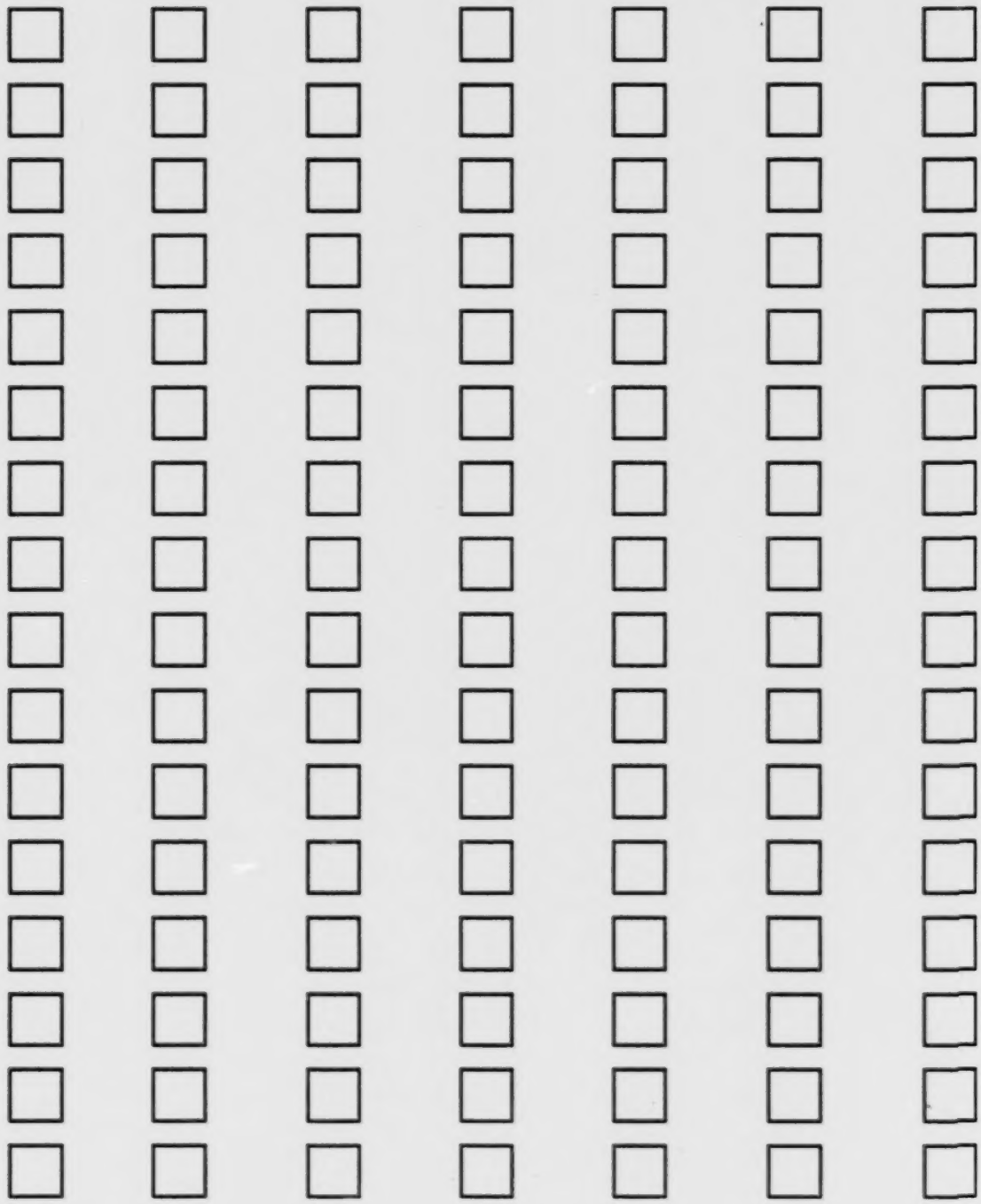
Activity 5: Creative Additions

Add commentary or more art work to some of your printed designs.

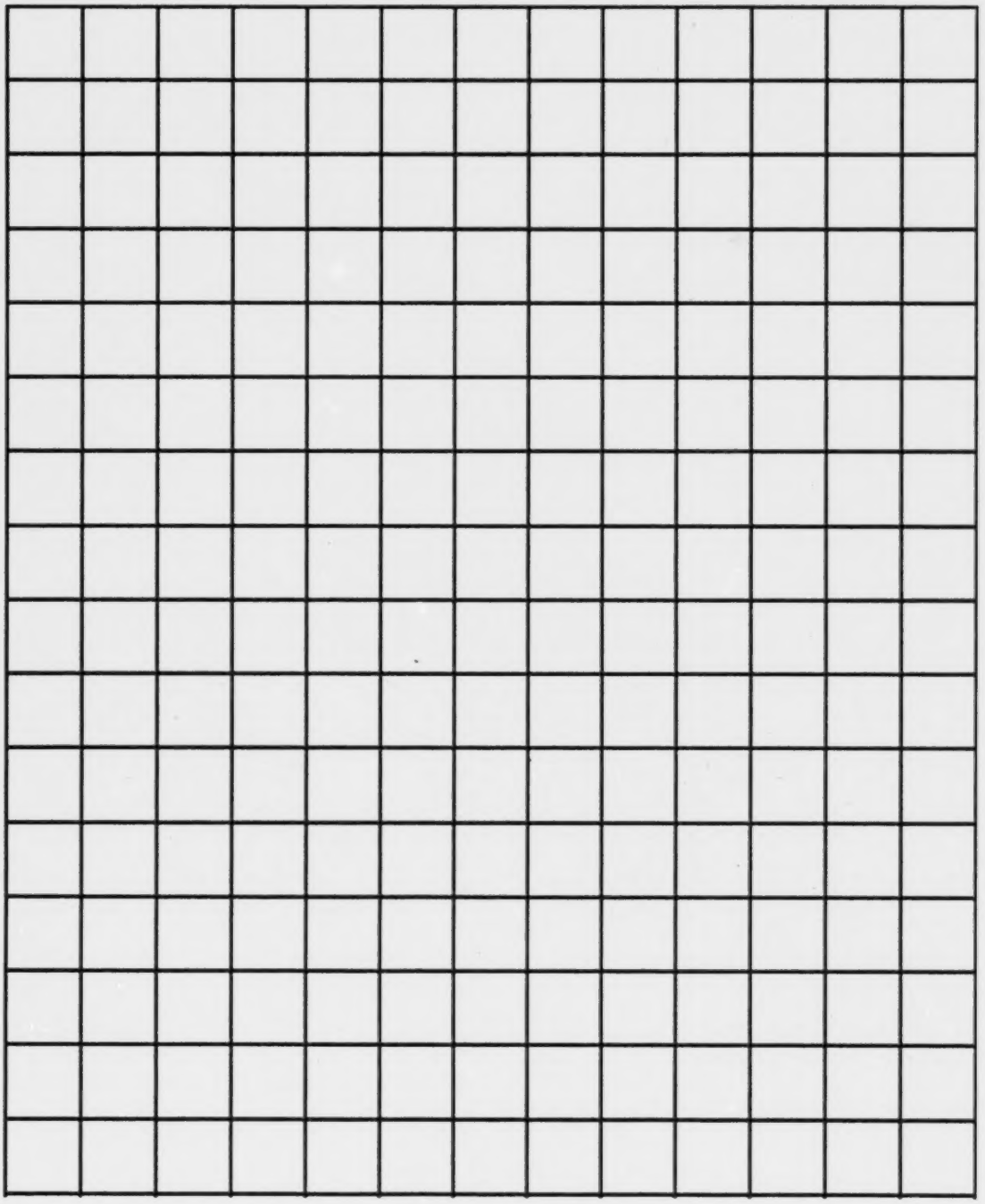
Key Summary for COLORS

Key	Turtle ...	Color name
A	Draws straight segment	
R	Draws quarter circle clockwise	
L	Draws quarter circle counterclockwise	
Z	Moves ahead (no trail)	
T	Turns 30° clockwise	
S	Changes size of design; enter a number and press Return/Enter Numbers <1 make smaller designs (e.g., 0.2, 0.7) 1 makes the design the original size Numbers >1 make larger designs	
K	Clears page so you can start over	
-	Erases previous color block and piece of the design	
N	Starts new line of color blocks	
Q	Quits the program (Type START to begin again.)	
	To print the graphics and text as they appear on the screen, quit the program, type PRINTSCREEN, and then press Return/Enter	

Colored Pattern Master Worksheet 1



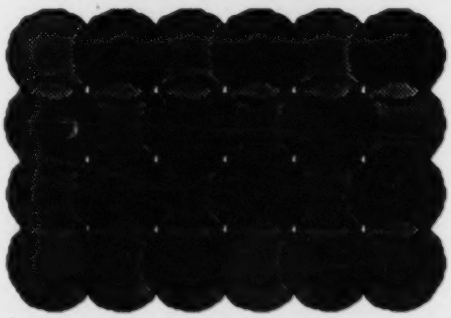
Colored Pattern Master Worksheet 2



Chapter 3. Sticker Designs

Summary

Filename: STICKERS
Grade Level: J/I
Color: Recommended



Many students are familiar with making patterns with gummed paper squares, circles, and diamonds. This program allows students to create such patterns on a computer. Such experiences help them deepen their understanding of the properties of simple geometric shapes, give them practice at using the properties of shapes to create geometric designs, and build skills related to analyzing geometric configurations.

Getting Started

1. Get the page STICKERS.
2. Type START and press Return/Enter.
3. You see a + cursor on the page. There is a > prompt in the Command Center. You then choose C, S, T, H, or R to draw a shape.

4. You will then be prompted to enter the size of the shape. Begin by entering 50.
5. You are now ready to use the keys described in the following section.

Instructions

Drawing Shapes (C, S, T, H, and R keys)

The following shapes can be drawn using the key shown below the picture.

Once a shape is selected, the user is asked to enter the diameter of the shape. The diameter entered remains in effect until a *different* diameter is entered for *any* of the shapes.

Keep in mind that the cursor appears in the middle of a shape.

Erasing a Shape (E Key)

Place the cursor at the center of the shape to be erased and press the E key. Repeated pressing of this key toggles between two pen states: PD to draw and PE to erase. When you see PE in the Command Center, use the appropriate shape key to erase the shape. Press the E key again and you will see PD, indicating that you are again in drawing mode.

Drawing a Grid (G Key)

To assist in placing shapes, a grid with ten turtle steps between the dots of the grid can be drawn using the G key.

To remove the grid, use the E key to switch to erase mode and press the G key again.

Note that any dots in the design that are grid dots will be erased if you erase the grid.

Placing the Shape (Arrow Keys and Delete Key)

Use the arrow keys to move the cursor before drawing a shape. The cursor can move either 1 turtle-step at a time or 10 turtle-steps at a time. Pressing the Delete key alternates between a slow and fast mode. When you see "Slow" in the Command Center, the cursor moves one turtle step with each press of an arrow key; when you see "Fast," the cursor moves 10 turtle steps. Use the Delete key at any time to switch between slow and fast modes.

Orienting the Shape (A Key and < > Keys)

Press the A key and type a number of degrees to define an angle increment. Then press the < key or the > key repeatedly to rotate the shape in a counterclockwise or clockwise direction respectively by the defined angle increment. The arrow in the upper right corner of the page indicates the present orientation of the shape.

Rotation of shapes only works with the five predefined shapes. You cannot rotate shapes created using the M key. (See the following instructions.)

Adding Color (I and F Keys)

Press the I key (for Ink) to cycle through the available colors. If you can't see the cursor, it is the same color as the background.

To fill a region with color, place the cursor in the desired region and press the F key.

If you are using a monochrome monitor, you will only have the background color and pen color available for use. If you cannot see the cursor, it is set to the background color. Use the I key to change the pen color to another color.

Clear the Page (K Key)

Press the K key to clear all graphics from the page.

Making Your Own Sticker (M Key)

You can add additional lines to the your design and define a shape you can use again by first pressing the M key. Then move the + cursor over the desired initial point and press the * key. Use the arrow keys to move to a second point and again press *. Continue until the desired number of joined segments have been defined. You should see a dot at each point, although no lines will be drawn. Press the D key to indicate you have finished defining the set of segments.

At this point you are asked to select a single-letter name for the set of segments. Use only names in the given list and don't use the same name for two different sets of segments. Now the set of segments will be drawn (or erased if pen state is PE) each time the selected letter is typed. The cursor's position when the new name is used becomes the position of the initial point of the newly named points.

Note that you cannot change the turtle speed after you have pressed the M key, and you cannot rotate the shapes you create using the M key.

Printing the Design (P Key)

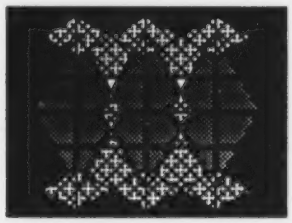
Press the P key and respond Y (yes) to print the design. Press N (no) if you change your mind.

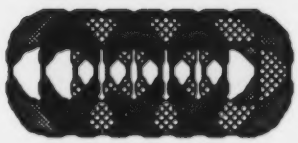
Quitting the Program (Q Key)

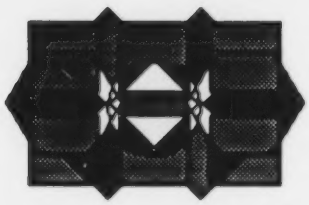
Press the Q key to quit the STICKERS program. To restart, type START.

Activities

Create a variety of designs. Show the results to a classmate, describing how you created it. Here are some ideas.







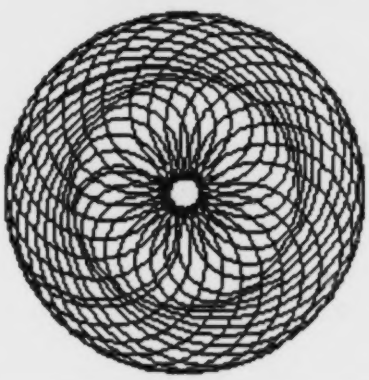
Key Summary for STICKERS

Shape Keys C, S, T, H, and R	Draw the following shapes
E	Toggles between Pen Down (PD) and Pen Erase (PE)
G	Draws a grid with a spacing of 10 turtle steps.
Arrow keys	Move the cursor up, down, left, and right
Delete	Switches between slow—one turtle step—and fast—ten turtle steps—when using the arrow keys
A	Defines angle of rotation; enter a number of degrees and press Return/Enter
< >	Rotates shape clockwise (>) or counterclockwise (<) by the angle defined using the A key
I	Cycles through the available pen colors
F	Fills the region under the cursor with color
K	Clears the page so you can start over
M	Makes supplementary lines and defines your own sticker; * defines the points in the line; D indicates that you are done defining new points
P	Prints the page
Q	Quits the program (Type START to begin again.)

Chapter 4. Circular Fraction Paths

Summary

Filename: CPATHS
Grade Level: J/I
Color: Optional



With the CPATH program, students can create a wide variety of interesting and beautiful geometrical designs using arcs of circles and straight-line segments. While creating these designs, students will consolidate some of their ideas about fractions. The size of the circles (and segments) drawn as well as the fractional amount of each circle to be drawn can be defined by the student.

Getting Started

1. Get the page CPATHS.
2. Type START and press Return/Enter.

3. The keys described in the following section allow the user to draw a variety of circular paths.

Be sure to press Return / Enter after each instruction.

Instructions

Setting the Size (S Key)

Pressing the S key and typing a number sets the size to be used. Thus, entering S4 sets the size to 4. After entering the S command, nothing happens until a drawing command is entered.

Drawing Arcs and Circles (L and R Keys)

The L key draws counterclockwise circles (to the left) and the R key draws clockwise circles (to the right). Both L and R are followed by a number that determines the fraction of a circle to be drawn. Thus, R1 draws a full circle, while R5 draws one-fifth of a circle.

For example, the commands S4 and then R3 draw one-third of a circle of size 4.

Drawing Line Segments (F Key)

The F key moves the turtle forward a distance determined by the last S (size) command.

Repeating Commands (R Key)

The R key can be used to repeat all of the commands entered since typing START or since the last E (erase) command. (See the following instruction.)

For example, if you erase all previous commands and then enter the following commands

S4

R3

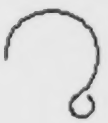
R3

S1

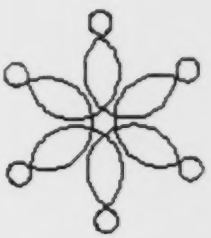
L2

L3

you see



If you then press the R key and Return/Enter six times, you see



Erasing Commands (E Key)

You can remove the commands you have entered since you began (or last used the E key) by pressing the E key.

Note that the commands are removed, but the design remains on the page.

Erasing the Page (K Key and CG)

Use the K key to clear all drawing from the page and return the turtle to the home position at the center of the page. Use CG to remove the graphics from the page but leave the turtle in its current location.

Note that clearing the page of graphics does not *remove the commands. You must use the E key to remove the commands.*

Also note that commands are repeated even if you have used the K key or CG to clear the page.

Changing the Pen State (T key)

The T key toggles between PU and PD. When the turtle has the pen up, the turtle does not leave a trail when it moves.

Changing the Turtle State (HT and ST)

HT hides the turtle from view but leaves the pen down. ST makes the turtle visible.

Changing the Size of a Drawing (X Key)

The X key followed by a number changes the size factor used in a drawing. Thus, X0.5 makes the drawing half as big as X1, while X2 makes the drawing twice as big.

If the design shown above is drawn, and then you enter X0.5 followed by the R key and Return/Enter six times, you see

Note that the X key does not erase the page or clear the screen.

Printing the Design (P key)

Press the P key and respond Y (yes) to print the entire page.

Quitting the Program (Q Key)

Press the Q key to quit the program. To start the program again, type START.

Note that all commands that have been entered are lost when you press the Q key.

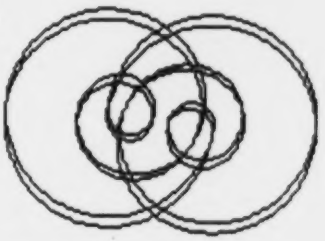
Activities

Activity 1: Free Exploration

Draw a variety of simple designs familiarizing yourself with the commands in this chapter.

Activity 2: Spirals

Create a variety of spirals and other designs related to spirals.



Activity 3: Using S0

Experiment making designs that use S0; that is, make the size equal to zero.

Activity 4: Play Scientist

Try to make discoveries that let you make predictions about your designs.

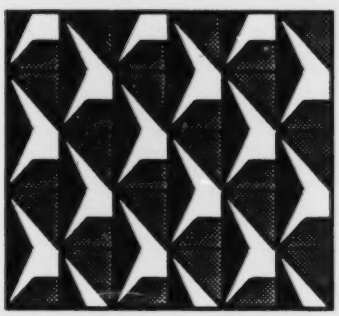
Key Summary for CPATHS

S*number*	Sets the size to *number*
L*number*	Draws 1/*number* of a circle counter-clockwise to the left
R*number*	Draws 1/*number* of a circle clockwise to the right
F	Moves the turtle forward, drawing a line segment with a length equal to the current size (S command)
R	Repeats all previous commands
E	Erases all previous commands
K	Clears the page and puts the turtle in home position
CS	Clears the page and leaves the turtle in the current position
T	Toggles between Pen Down (PD) and Pen Up (PU)
HT	Hides turtle
ST	Shows turtle
X*number*	Multiplies the size of the design by *number*
P	Prints the page
Q	Quits the program (Type START to begin again.)

Chapter 5. Design Master

Summary

Filename: CELLS
Grade Level: J/I
Color: Optional
Not available for the Apple



This program lets the user draw on squares within a grid to create a wide variety of geometric designs. Users can investigate the effects on designs created by altering such things as line, shape, position, symmetry, color, and number.

Getting Started

1. Get the page CELLS.
2. Type START and press Return/Enter.
3. The user is asked to define a grid. The first question asks for the number of squares in one *column*. The second question asks for the *number of columns*. The number of squares in one column may be from 1 to 30 and the number of columns may be from 1 to 30.

4. A > prompt appears. The user may now use the following commands.

Instructions

Drawing a Grid (G Key)

A grid may be drawn to show the rows and columns described in the initial answers given by the user. Press the G key to see the grid. (Be sure the + cursor is visible and that the pen is down.)

The grid may be erased by changing the pen state (See the following S command.) and pressing the G key again.

Moving the Cursor (Arrow Keys)

The arrow keys allow the user to move from square to square within the grid, one square at a time.

Changing the Pen State (S Key)

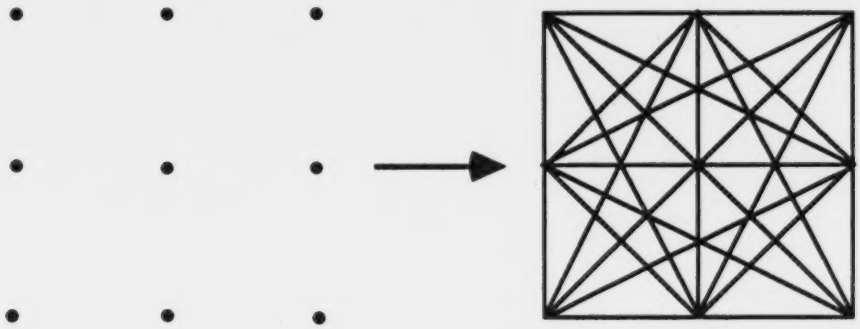
Pressing the S key repeatedly cycles through four pen states: PD—to draw; PE—to erase; PX—to draw in pen reverse mode; and PU—to leave no line when the turtle moves. (See your *LogoWriter* documentation to learn more details about PX.)

Clearing the Page (K Key)

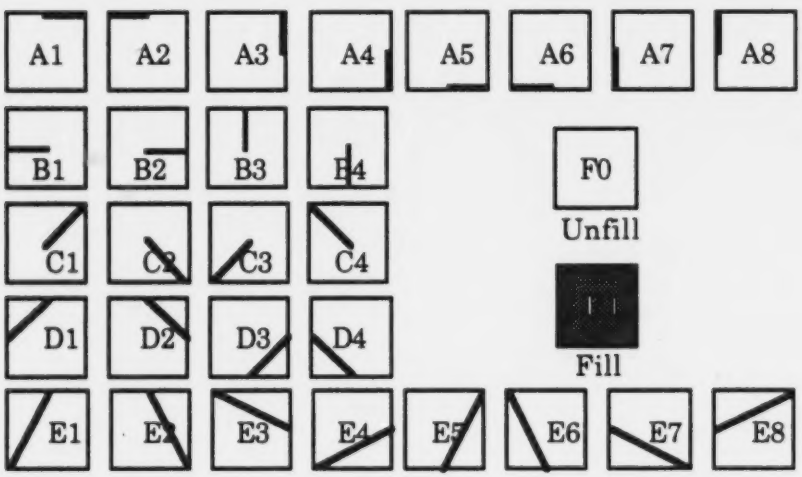
Pressing the K key removes all of the drawing from the page and redraws the grid if the pen state is in a draw mode.

Brush Instructions (B and M Keys)

The B key is used to begin defining the brush to be used. Think of a square with dots at each corner, at the midpoint of each side, and in the middle. Draw line segments connecting the points. The user can choose which segment to use to define the brush.



Line segments are entered by using a two-character code for each of 28 possible line segments.



Enter as many of the two-character codes as desired, one segment at a time. *Be sure to press Return / Enter after each entry.* Press the F key when finished entering brush instructions. These brush instructions remain defined until the B key is pressed again.

Note that while F0 and F1 do not define a line segment, they still are used to define a brush instruction. These two brush instructions are used to fill and unfill in the picture.

Once a brush pattern has been defined using the B key, the M key is used to actually draw the pattern. Move the cursor to the desired square, and press the M key to see the pattern.

For example, suppose you type B and then enter the brush instructions E1, C3, and B2. Remember that you *must* press Return/Enter after each of the three commands. Then enter F to indicate you have finished defining this brush and move the cursor to the correct place on the grid. Press the M key. The following pattern results.

Note that the I key can be used to define the color of the square and the S key can be used to draw or erase a brush pattern after it has been defined.

Filling/Unfilling a Region (B and F Keys)

To fill or unfill a region, first select the B key. *Note that the previous brush instructions will be erased.* Then enter F1 if a region is to be filled or F0 if a region is to be unfilled. Press the F key to indicate that you have finished defining the brush.

Next, using the U, D, L, and R keys (See the following section.), position the cursor in the area to be filled or unfilled. Press the M key to make the brush instructions (fill or unfill) work. Fill will fill only this one region; unfill will unfill all regions in all squares of the grid.

When filling a region, be sure to use the U, D, L, and R keys to return to the center of a square (0,0) before you draw any new brush patterns. Also, be aware that if the line segments are the same color as the fill, and you use unfill, both fill and segments will be erased.

Moving the Brush (U, D, L, and R Keys)

Use the U (up), D (down), L (left), and R (right) keys to move the cursor within a square to fill or unfill a region. Always use these keys to move to the center of a square before using a new brush pattern.

Choosing the Ink Color (I Key)

Pressing the I key repeatedly cycles the cursor through the available colors. After you have defined the brush to be used using the B Key, select the desired ink color by pressing the I Key.

If you are using a monochrome monitor, the cursor will appear and disappear as you repeatedly press the I key. Be sure the cursor is visible when you wish to draw.

Printing the Page (P Key)

Press the P key and respond Y (yes) to print the page.

Quitting the Design Master Program (Q Key)

Press the Q key to leave the CELLS program. Type START and press Return/Enter to begin again.

Example

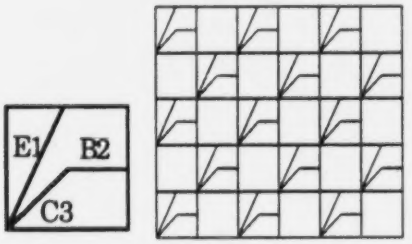
A Sample Design

1. Start the program by typing START and pressing Return/Enter. (If you are already in the CELLS program, press the Q key to quit and then type START to restart.)

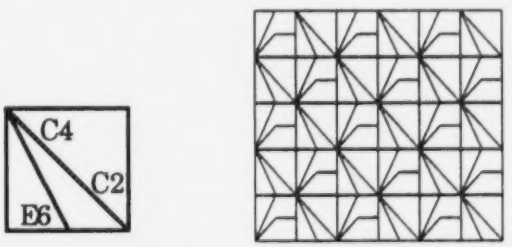
2 Choose five squares in a column and six columns of squares. Then press the G key to draw the grid. (You may want to use the Design Master Worksheet to help you plan your design.)

3. Press the B key and enter the brush instructions E1, C3, and B2. Be sure to press Return/Enter after *each* instruction. Press the F key to finish defining the brush.

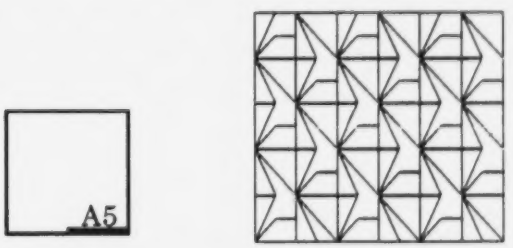
4. Use the M key to draw the brush pattern. Then use the arrow keys to move to alternate squares and the M key to draw the brush pattern again.



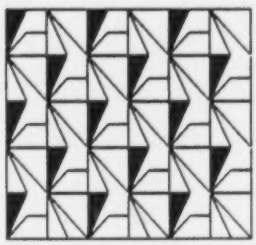
5. Create a new set of brush instructions that consists of C4, C2, and E6. Use this pattern to draw on the other squares.



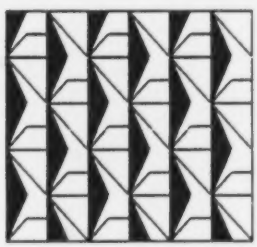
6. Again, change the brush instructions to A5. Press the F key to finish entering brush instructions. Use the S key to change the pen state to PE. Use the M key to remove one segment on alternate squares.



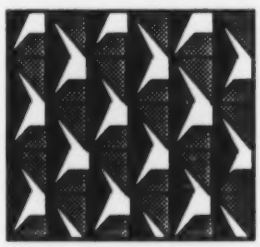
7. Change brush instructions to F1 to fill a region. (Remember to end with the F key.) Use U, D, L, and R keys to position brush before filling a region. Be sure to use the S key to change the pen state to PD. When the cursor is over the correct area, press the M key. Note that each region has to be filled separately.



8. Change brush position to fill the second region.



9. Fill two more regions with a new color.



Activities

Activity 1: Free Exploration

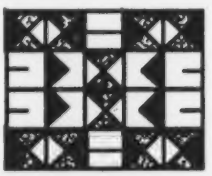
Practice using the commands in this chapter. Make some experimental designs.

Activity 2: Design Strips

Create a design on a single strip of squares. Use the worksheet at the end of this chapter to help you decide on your design.

Activity 3: Designs on a Grid

Using the worksheet at the end of this chapter, create your own design on a grid of squares.



Activity 4: Investigating Designs With Grids

Investigate the effect of different grid sizes on designs. Use the worksheet at the end of this chapter.

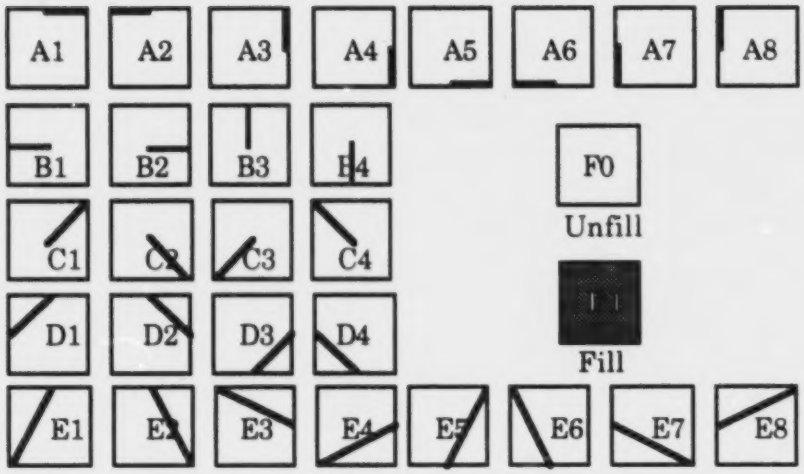
Activity 5: Art Project

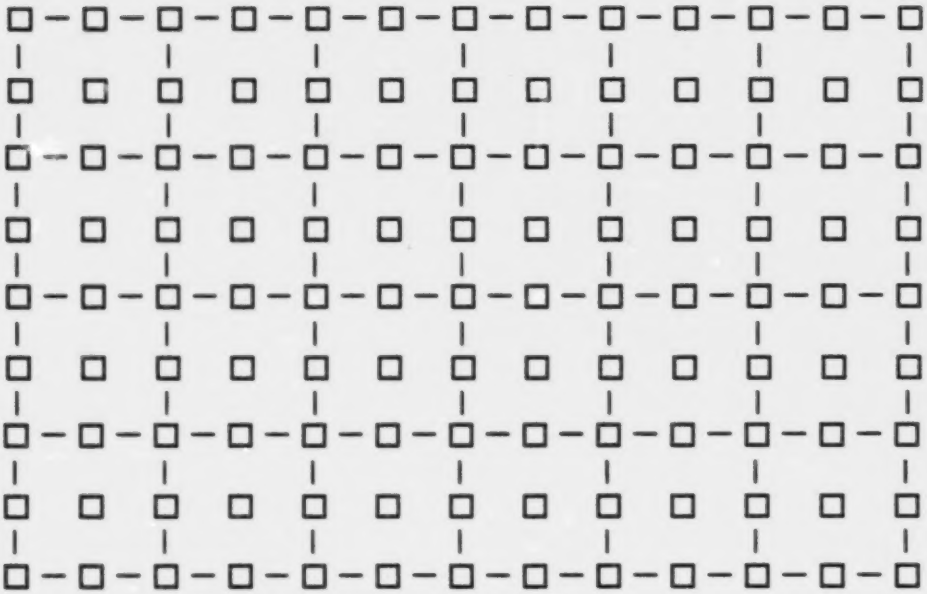
Make a large handmade version of one of your Design Master designs.

Key Summary for CELLS

G	Draws a grid of squares (if the pen state is PD)
Arrow keys	Move brush to desired square
S	Cycles through pen states Pen Down (PD), Pen Erase (PE), Pen Reverse (PX), and Pen Up (PU)
K	Clears the page and redraws the grid if the pen state is PD
B*code*	Defines the brush pattern (See code choices in Instructions section.)
M	Creates the defined brush pattern on the square in which the cursor is located
F	Fills or unfills a region; enter F1 or F0 after B key
U L R D	Move the brush within a square when filling or unfilling a region
I	Cycles through available colors
P	Prints the page
Q	Quits the program (Type START to begin again.)

Design Master Worksheet

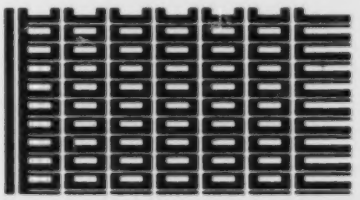




Chapter 6. Tartan Design

Summary

Filename: TARTAN
Grade Level: J/I
Color: Optional



TARTAN enables the user to draw parallel sets of vertical and horizontal lines of varying color, width, drawing state, separation distance, and fractional amount. It can be used to create a wide variety of tartan-like designs. The creation of such designs reinforces a number of basic whole number and fraction concepts and operations in addition to applications of parallel and perpendicular lines.

Getting Started

1. Get the page TARTAN.
2. Type START and press Return/Enter.
3. The user is prompted for the desired width and height of the area to be used for drawing. Be sure to keep the answers within the dimensions of the page.
4. Next the user must decide whether to draw horizontal or vertical lines.

5. A state line appears in the Command Center. This line indicates the current coordinates of the pen, the pen width, and the pen state (PU, PD, PE). For more details see the following instructions.

   In this activity, all of the directions for drawing a pattern are entered first, and then the pattern is drawn.

Instructions

Moving the Pen (Arrow Keys)

To move the pen, use the four arrow keys. These keys move the pen one turtle-step at a time. The state line in the Command Center shows the coordinates of the pen. The point 0,0 is at the lower left corner of the drawing area.

Note that if you want the starting point of succeeding designs to align exactly with the 0,0 point of a design you have already drawn, it may be necessary to adjust it by using the arrow keys.

Selecting a Pen Width (W Key)

The width of the pen can vary from 1 to 16. Repeatedly pressing the W key cycles through the choices. Look at the page and the status line to determine the current pen width.

Selecting the Pen State (S Key)

Repeatedly pressing the S key cycles through the three available pen states: PU for no lines drawn, PD to draw, and PE to erase lines. The current pen state is displayed in the status line.

Selecting the Pen Color (I Key)

After you have defined the drawing area, press the I key repeatedly to cycle through the available pen colors. Notice the color of the cursor on the page to see the current pen color.

If you are using a monochrome monitor, then the cursor will appear and disappear as you press the I key. Be sure the cursor is visible before you draw.

Changing the Background Color (B Key)

After you have defined the drawing area, pressing the B key changes the background color. Press the B key repeatedly to see the choices of background color.

Drawing Fractional Parts of Lines (F Key)

When the F key is pressed, the user is first asked for the number of parts into which a line is to be divided. Next, the fractional segments that are *not* to be drawn is requested. For example, if 5 is entered for the number of parts of the line, then the user might enter 2 4 for the parts that should not be drawn.

Note that the number of all of the parts to be omitted must be entered and that the numbers must be entered with a space between them. Do not put any punctuation in the list of numbers entered.

Making Your Drawing (D Key)

When you have made all of the decisions about the set of vertical or horizontal lines that you want to draw, the D key asks you for vertical or horizontal separation distance, depending on whether you are drawing horizontal or vertical lines.

Note that the separation distance actually includes the steps in the line *and* the space between the line and the near edge of the next line. For example, if a line is 1 step wide, and the separation distance is 5, then the next line will be drawn 4 (not 5) steps away from it. If a line is 16 steps wide and the separation distance is 10, the lines will overlap, producing a rectangle of solid color.

Press Return/Enter and the drawing appears on the page. After a set of lines has been drawn you can specify another set of pen and line conditions and then use the D key again.

To Quit or Continue (C and Q Keys)

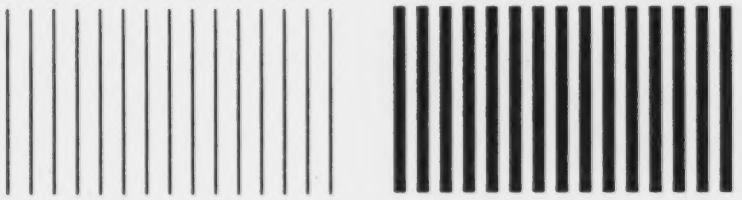
When you have completed a set of horizontal or vertical lines, you are asked if you want to quit or continue with the drawing area you have been using. Pressing the C key allows you to clear the screen or continue working on the current

drawing. If you want to redefine the drawing area or leave the program, press the Q key and then Return/Enter. Type START and press Return/Enter to begin again.

Examples

Example 1

Below are two examples of vertical lines with the horizontal separation distance set to 10. The width of the pen for the drawing on the left is 1; the width of the pen on the right is 5.

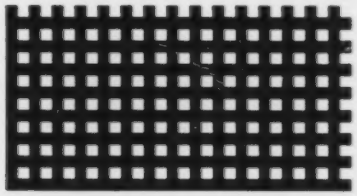


Example 2

The following two examples are of horizontal lines with the vertical separation distance set to 10. The pen width of the example on the left is 1; the pen width on the right is 5.

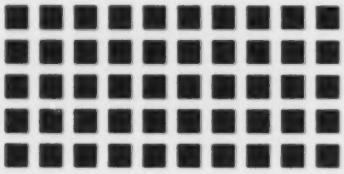
Example 3

This example combines the vertical lines on the right from the first example with the horizontal lines on the right from the second example.



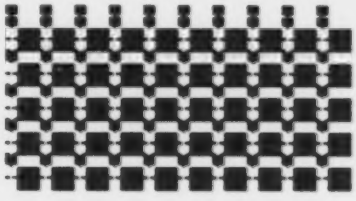
Example 4

In the following example, horizontal lines with pen width 10 and vertical separation distance of 15 are intersected with vertical lines of pen width 5 with horizontal separation distance of 15. The vertical lines had the pen state set to PE.



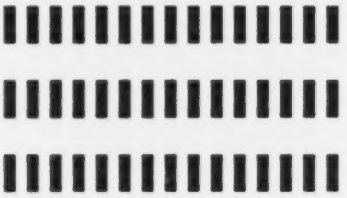
Example 5

The following example is the same as example 4 except that the pen state of the vertical lines is set to PX.



Example 6

In the following example, vertical lines of pen width 5 separated by a distance of 10 were drawn. The number of fractional parts was set to 5 and parts 2 and 4 were not drawn.



Activities

Activity 1: Exploration

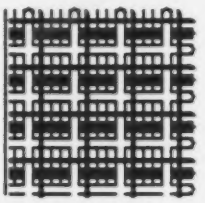
Create tartan patterns by experimenting with different pen widths, pen states, and separation distances.

Activity 2: Simple Patterns

Create designs working solely in the vertical mode (or solely in the horizontal mode).

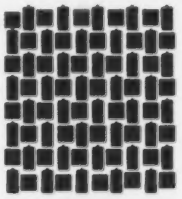
Activity 3: Intersecting Lines

Create designs using sets of horizontal and vertical lines.



Activity 4: Basket Weaves

Create basket weave designs.



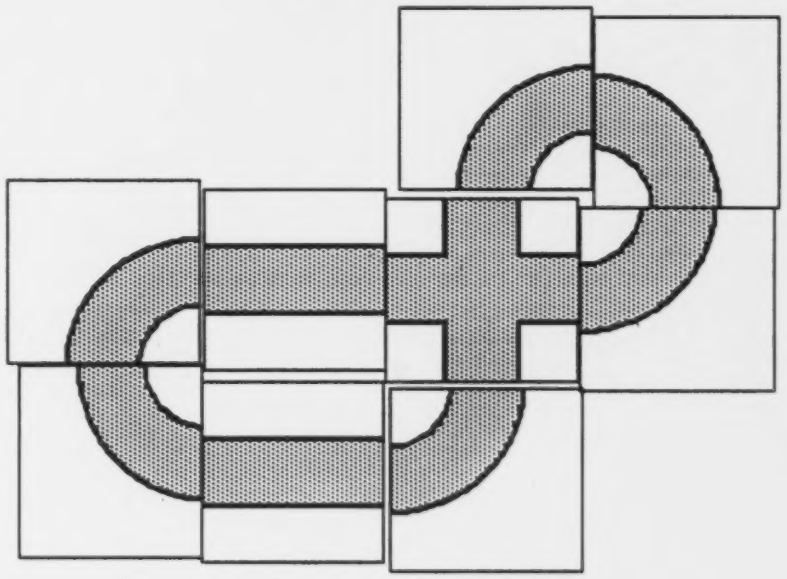
Key Summary for TARTAN

Arrow Keys	Move the pen; coordinates show in the status line in the Command Center
W	Cycles through available pen widths; current pen width shows in the status line in the Command Center
S	Cycles through pen states Pen Down (PD), Pen Erase (PE), and Pen Reverse (PX); current pen state shows in the status line in the Command Center
I	Cycles through the available pen colors
B	Cycles through the available background colors
F	Requests which fraction parts of a line should *not* be drawn
D	Draws the specified lines after asking for the separation between lines
C	Clears the screen or continues with the current drawing
Q	Quits the program (Type START to begin again.)
	To print the graphics and text as they appear on the screen, quit the program, type PRINTSCREEN, and then press Return/Enter

Chapter 7. Making Tracks

Summary

Filename: TRACKS
Grade Level: P/J
Color: Optional



The program TRACKS is a drawing program that allows students to participate in a variety of activities involving the construction of shapes, tracks, and designs.

Getting Started

1. Get the page TRACKS.
2. Type START and press Return/Enter.

3. You see a > prompt. Use the keys described in the following section to draw your tracks.

Instructions

Drawing Straight Lines (Arrow Keys)

The arrow keys are used to draw straight lines. The up arrow always draws to the top of the page, the right arrow to the right, the left arrow to the left, and the down arrow to the bottom of the page.

Drawing Curves (R and L Keys)

The R key draws a quarter circle to the right—clockwise. The L key draws a quarter circle to the left—counter-clockwise.

Changing the Color (I Key)

Repeatedly pressing the I key changes the color of the ink used to draw. You can see the color of the turtle change as you press the I key.

Changing the Pen State (S Key)

Pressing the S key selects PU or PD.

Working with the Turtle (T and X Keys)

The T key displays the turtle briefly; the X key stamps the image of the turtle at the current location of the turtle. Use the T key to see where the turtle is currently located before using the X key.

Backing Up (- Key)

Each time the - key is pressed, the last piece of track is erased and the command to draw that piece of track is removed from the list of track commands.

Note that using the - key causes the pen color to be reset to black.

Starting Over (K Key)

Pressing the K key erases the drawing on the page *and* removes from memory the commands used to make the track.

Quitting the Program (Q Key)

Press the Q key to quit the TRACKS program. If you want to see the turtle race around your track, see the following RACE command. If you want to start over with a new track, type START.

The RACE Command

Use the RACE command to make the turtle race around your completed track.

- Your track must be a closed loop that ends at the same place that it began. Stamp the turtle at the beginning of the track.
- Use PU and move the turtle to the beginning of the track.

Then press the Q key to leave TRACKS, and type

```
RACE
```

to see the turtle follow the track. You can use other Logo commands with the RACE command. For example, the instruction

```
REPEAT 6 [RACE]
```

will send the turtle around the track six times.

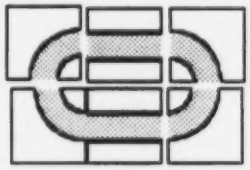
Activities

Activity 1: Making A Paper Track

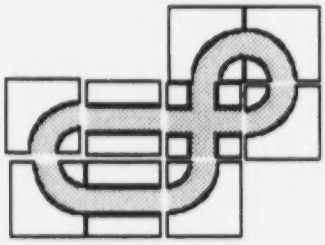
This activity does not use the computer. Students use cut-out copies of track tiles to make a track of their choosing. You will find worksheet masters of these tiles at the end of this chapter.

Initially students can be encouraged to construct tracks any way they wish. Later, students can be challenged to build tracks in certain specified ways, for example,

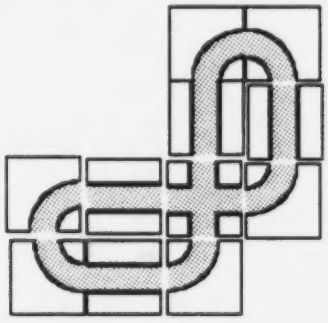
- make a closed track



- make a track that crosses itself



- make a track within a 4 x 4 (or 5 x 5, etc.) square



- make a track that looks like one someone else made

Activity 2: Making Computer Tracks

With TRACKS running, repeat Activity 1 on the computer. Then use the RACE command to retrace the track.

Activity 3: Geometric Shapes And Designs

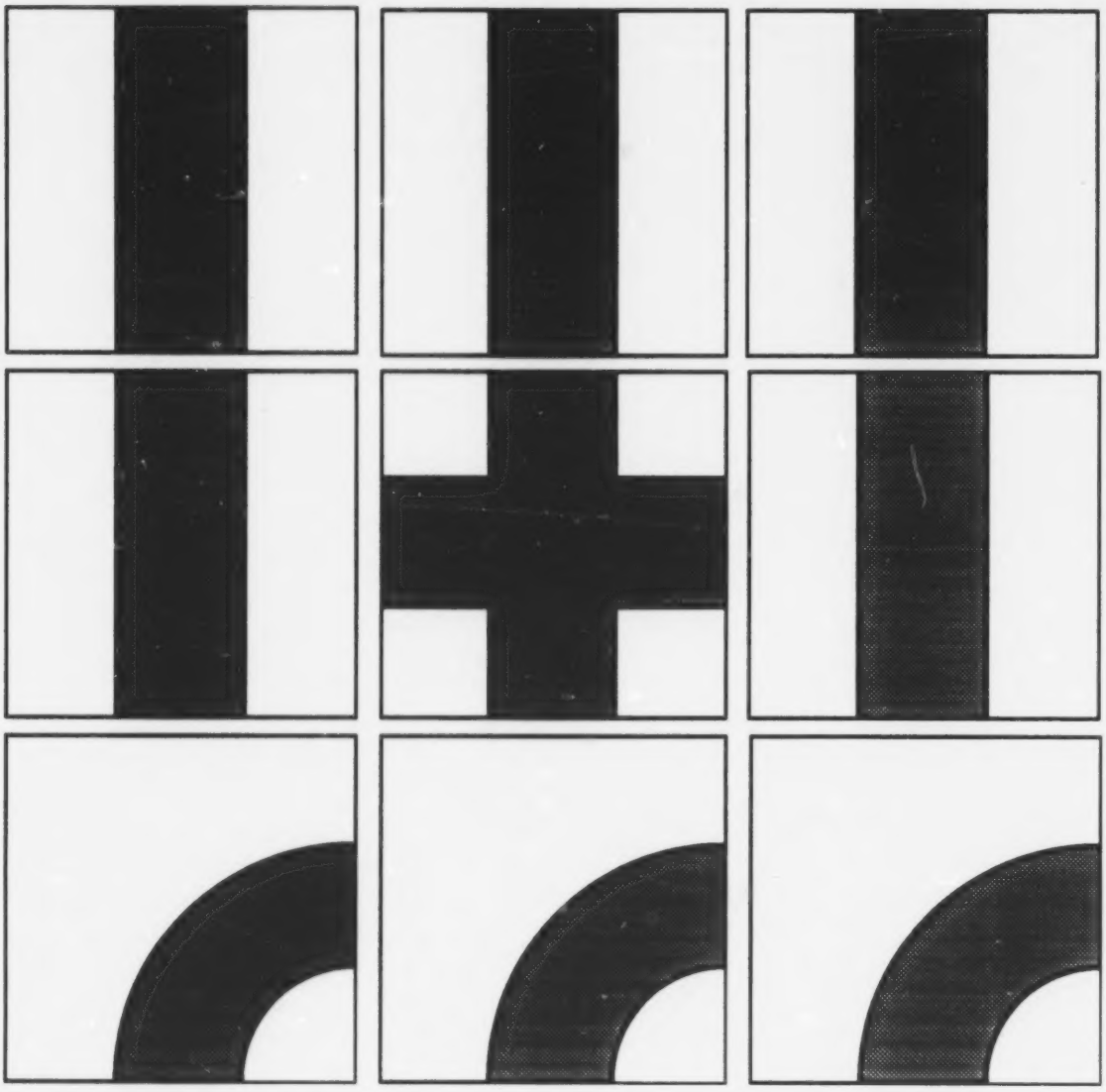
TRACKS can be used as a general purpose drawing program. Students can be challenged to create various designs or they can create drawing challenges for other students to try. Such challenges could be placed on activity cards, for example,

- Draw your initials
- Draw your name
- Draw your age
- Draw a car
- Draw a tic-tac-toe grid

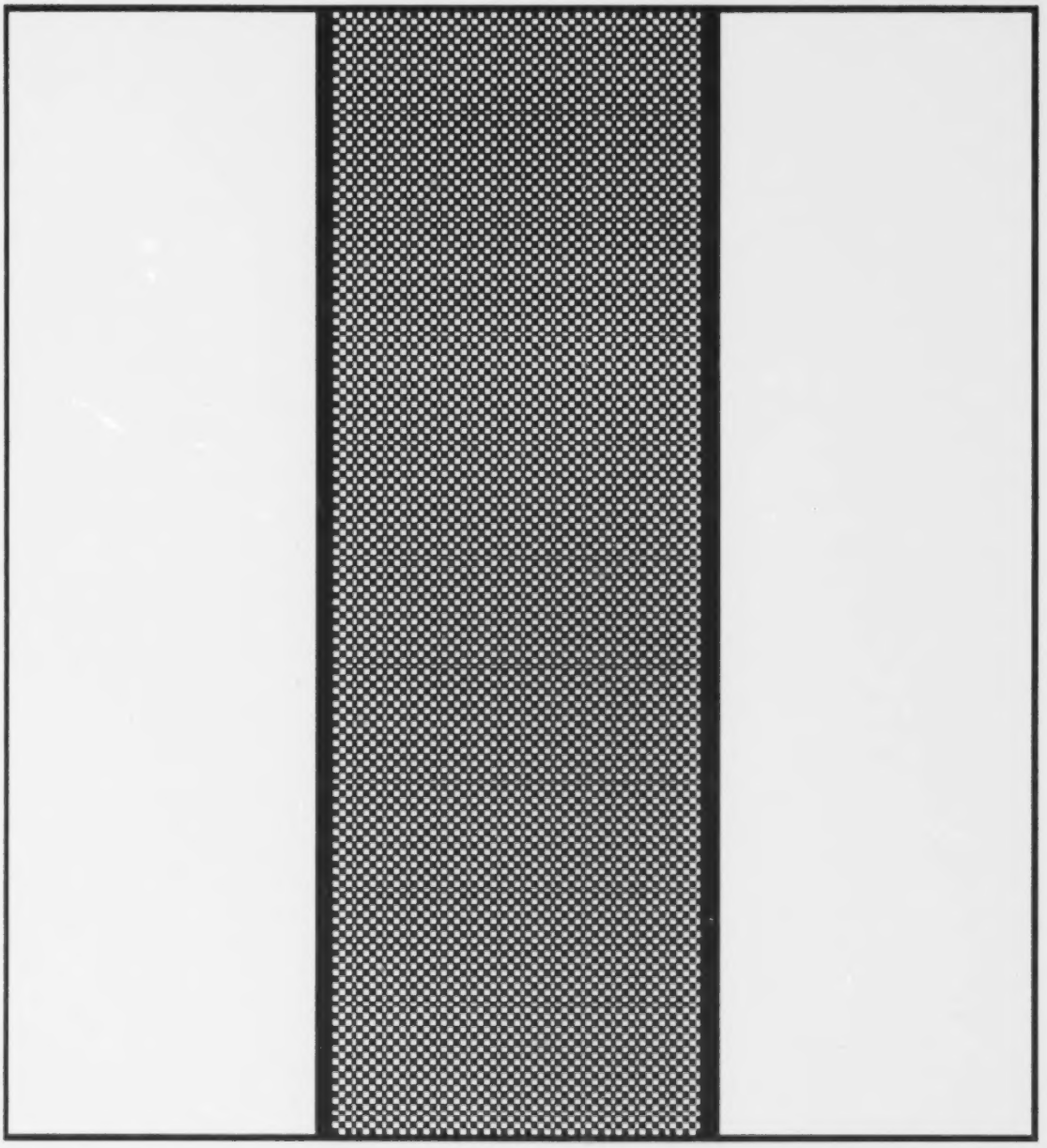
Key Summary for TRACKS

Arrow Keys	Draw straight line segments
R	Draws quarter circle clockwise
L	Draws quarter circle counterclockwise
I	Cycles through the available pen colors
S	Toggles between Pen Down (PD) and Pen Up (PU)
T	Displays turtle location (briefly)
X	Stamps a turtle at the current location
-	Erases last piece of drawing; removes command from list
K	Clears drawing and all of the commands used to make it
Q	Quits the program (Type START to begin again.)
	To print the graphics and text as they appear on the screen, quit the program, type PRINTSCREEN, and then press Return/Enter
RACE	Causes turtle to race around a track

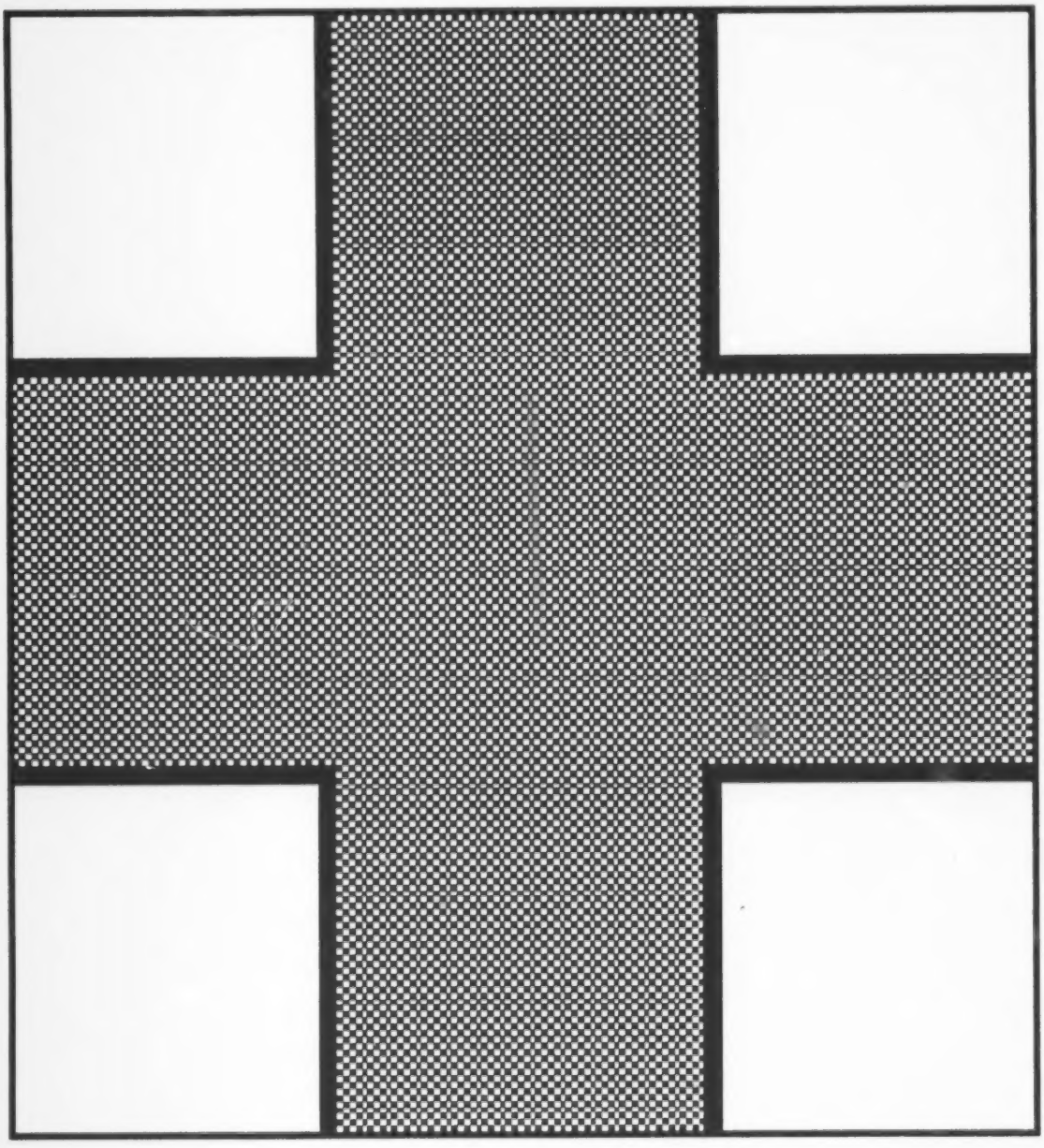
Track Tiles Worksheet



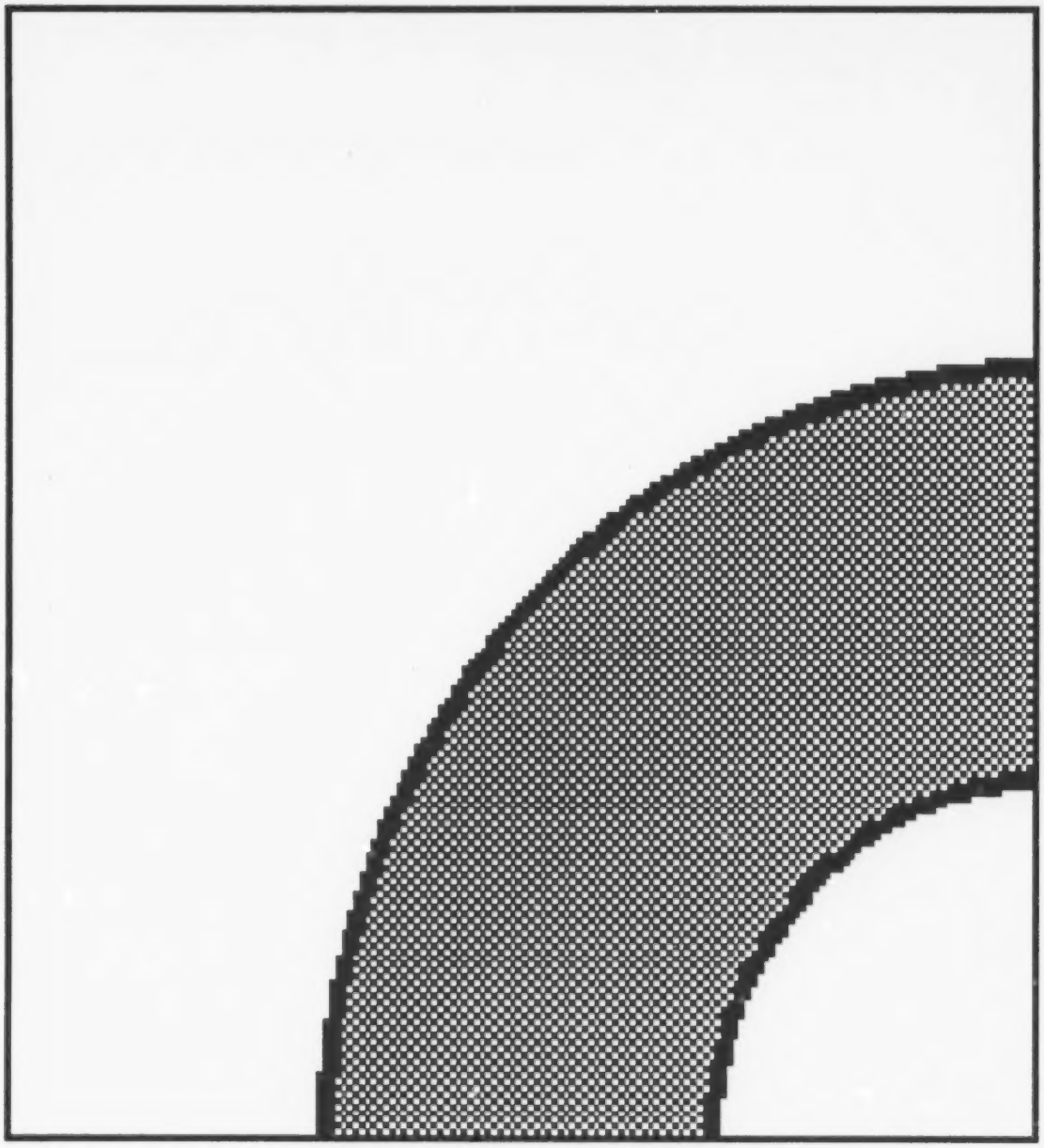
Track Tiles Worksheet



Track Tiles Worksheet



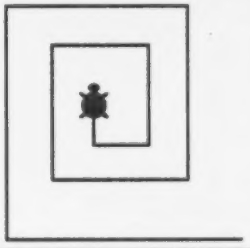
Track Tiles Worksheet



Chapter 8. Instant Logo

Summary

Filename: INSTANT
Grade Level: P/J/I
Color: Recommended



The INSTANT program presents beginning students with a mini-Logo language that allows them to draw with single-keystroke commands.

Getting Started

1. Get the page INSTANT.
2. Type START and then press Return/Enter.

Instructions

You can use several categories of keys with this INSTANT program.

Turtle Move (F, B, R, and L Keys)

The F key move the turtle forward 10 turtle steps.

The B key moves the turtle back 10 turtle steps.

The R key turns the turtle right 15°.

The L key turns the turtle left 15°.

Color Keys (I and C Keys)

The I key changes the color of the turtle and thus the color of the pen the turtle uses to draw. Repeatedly pressing the I key cycles through the available turtle colors.

The C key changes the background color. Repeatedly pressing the C key cycles through the available background colors.

Note that if you are using a monochrome monitor, the turtle and background colors will alternate between black and white. If the turtle disappears, press the C key so that it becomes visible again.

Pen State (S Key)

Pressing the S key causes a change in pen state. The pen may be down to draw a line, up to move without drawing, or in erase mode to erase a line. The current pen state is displayed in the upper left corner of the page. Repeatedly pressing the S key cycles through the available pen states.

Clearing the Page (K Key)

The K key clears the page so that a new drawing may be started. This command erases the current picture both from the screen and from memory. See the following description of the PICTURE command.

Getting Help (? Key)

The ? key provides a help screen so that students don't have to remember the key commands. Press the T key when you return from this help page to make the turtle visible again.

Quitting the Program (Q Key)

The Q key quits the INSTANT program. Type START and press Return/Enter to begin again.

Using the PICTURE Command

When you press the Q key to quit the INSTANT program, all of the keys pressed to create the design are stored in the program. To redraw the same design, type

```
PICTURE
```

in the Command Center. PICTURE causes the turtle to redraw all commands, including PE, PU, and PX.

Before you press the Q key, you can use Turtle Move to place the turtle in a new location. Then press the Q key and type PICTURE to redraw your design in the new location.

Activities

Activity 1: Free Exploration

Spend some time experimenting with the commands in the chapter. What colors are available? Can you recreate a picture you have already made?

Activity 2:

Create and print designs. These might be attractive designs for decoration or signs or posters.

Activity 3:

Create fairly simple designs. Print the designs. Then try to create designs that others have made.

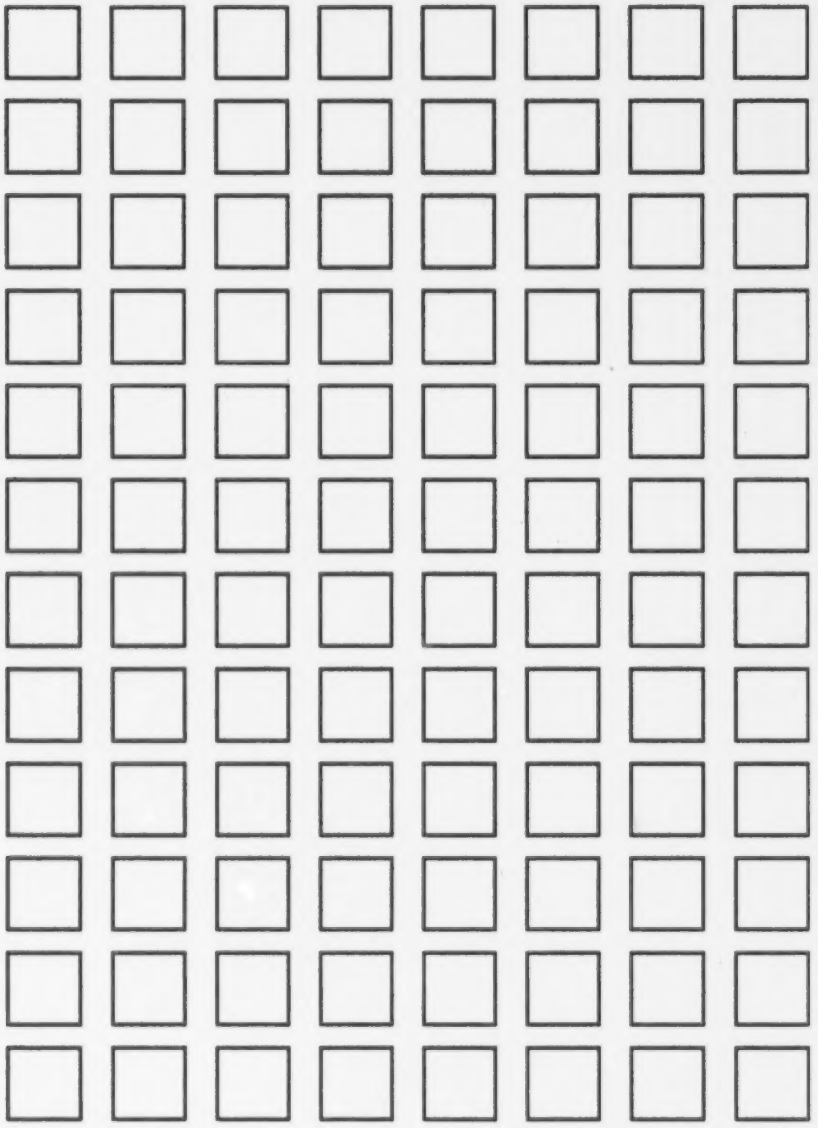
Activity 4:

Record the keystrokes used to draw or design using the worksheet at the end of this chapter. Then give this "program" to another student to see if they get the same design.

Key Summary for INSTANT

F	Moves the turtle forward 10 steps
B	Moves the turtle back 10 steps
R	Turns the turtle right 15°
L	Turns the turtle left 15°
I	Cycles through available pen/turtle colors
C	Cycles through available background colors
S	Cycles through pen states Pen Down (PD), Pen Up (PU), and Pen Erase (PE)
K	Clears the page and starts a new picture
?	Provides a help screen
Q	Quits the program; commands to draw the current design remain in memory (Type START to begin a new design; commands are erased.)
	To print the graphics and text as they appear on the screen, quit the program, type PRINTSCREEN, and then press Return/Enter
PICTURE	Redraws a picture (Press the Q key and type PICTURE.)

Design Planner Master Worksheet



Chapter 9. Lotsalists

Summary

Filename: LISTS
Grade Level: J/I/S
Color: Optional

Users need to know simple Logo commands to use this program effectively.

LISTS can be used as an introduction to writing and using Logo procedures and is a good program to use after students have had experience with INSTANT.

A Logo procedure is actually a named list of Logo instructions. With the LISTS program, the user instructs a turtle to move on the page. These instructions are automatically placed in a list that the viewer can have displayed. At any point, the user can give the current list a name. This is equivalent to defining a procedure. However, the user doesn't need to flip the page and paste or retype the instructions.

Getting Started

1. Get the page LIST.
2. Type START and press Return/Enter.
3. You are asked if you want to see the list on the page. Answer Y (yes) if you want the list continuously displayed.
4. A > prompt appears.

When asked whether to display the list, answer Y (yes) to display the list of Logo commands in the upper left corner of the page.

Users may enter Logo commands *or* use the single-keystroke commands described in the following section.

Be sure to press Return / Enter after each single-keystroke command or after each Logo command.

Instructions

Entering Commands and Restarting (S Key)

Any Logo instruction(s), including user-named lists (procedures), are saved in a list in the order entered. It is a wise idea to enter Logo commands one at a time. For example, typing

```
FD 50 (Return/Enter)
```

causes

```
list = FD 50
```

to be displayed on the page. Entering

```
RT 90 (Return/Enter)
```

causes

```
list = FD 50 RT 90
```

to be displayed on the page.

Note that if a syntax error is made by the user when entering an instruction, Logo will display an error message and the program will need to be restarted. Use the S key (rather than START) to restart without erasing the list of commands.

Placing the Turtle (U, D, L, and R Keys)

The turtle can be placed anywhere on the page using the U (up), D (down), L (left), or R (right) keys. These keys can be used at any time, but they are *not* recorded in the list of commands. Use these keys to place the turtle before making a drawing.

Selecting the Pen Color (I Key)

Repeatedly pressing the I key cycles through the available colors. The turtle changes color as you press the key and will draw using the current turtle color.

Note that colors are not *recorded in the list of commands.*

Running a List (A Key)

Pressing the A key causes the current list of commands to be run.

Erasing Commands and Graphics (-, Z, and K Keys)

The - key is used to remove the last command or line of commands that was entered at the > prompt.

Note that if you enter

```
>FD 50 RT 90 FD 30
```

and then press the - key, all three commands will be erased at once. Thus, to make correction of errors easier, it is wise to press Return / Enter after each single command.

The entire current list of commands can be removed with the Z key. The drawing on the page is unaffected.

The K key is used to remove graphics from the page. The list of commands is not affected.

Naming Lists (N Key)

Any name may be used for a procedure except for those single-keystroke commands defined for use within the program. Thus, you cannot name a procedure A, but you can name a procedure A1 or Andrea1.

Printing the Page (P Key)

Press the P key to print the current page. You will see both the drawing and the list (if it is displayed).

Quitting the Program (Q Key)

Press the Q key to quit the LISTS program. Type START and press Return/Enter to begin again with no user-defined procedures or lists. To keep the current list of commands and

procedures, type S to restart. (See the S command previously described.)

Activities

Use this chapter to introduce the idea of writing procedures and the idea of using procedures to define new more complex procedures.

Key Summary for LISTS

S	Restarts keeping the existing procedures and lists (if there is an error message)
U L R D	Place the turtle
I	Cycles through available pen colors
A	Runs the current list again
-	Erases the last set of instructions entered in the list; can be used repeatedly
Z	Removes the current list of commands
K	Clears graphics from the page
N	Names the current list
P	Prints the page
Q	Quits the program (Type START to remove the current list of commands and begin again.)

Chapter 10. Fractal Designs

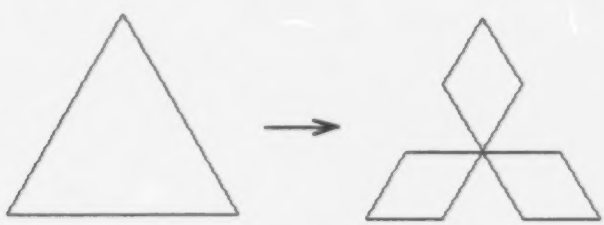
Summary

Filename: FRACTAL
Grade Level: I/S
Color: Recommended

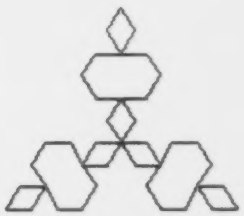
Note that this chapter does not explain fractals in detail or provide instruction about fractals. Such material will need to be provided by the teacher.

The FRACTAL program allows users to create and experiment with a variety of interesting fractal designs.

Consider a simple paper-cutting exercise. Start with an equilateral triangle, for example, and cut out a small equilateral triangle from the middle third of each side. Consider this as a "first level" of cuts. This first level of cuts results in a shape with 12 sides.



From the middle third of each of these sides, cut away smaller equilateral triangles. This second level of cuts results in the following figure.



Theoretically this process can continue indefinitely through any number of levels of cuts. The process results in a fractal design. A different fractal is produced by this procedure if the piece cut out of the middle of the sides is a shape other than an equilateral triangle.

A computer provides a non-cutting way of creating the above design.

Recall that entering the Logo commands

```
REPEAT 3[FD 90 RT 120]
```

draws an equilateral triangle with each side of length 90.

One of the cuts described above can be achieved by replacing the instruction FD 90 in the line of code above by

```
FD 30 RT 60 FD 30 LT 120 FD 30 RT 60 FD 30
```

That is, replace

with

Getting Started

1. Get the page FRACTAL.
2. Type START then press Return/Enter.
3. You are now ready to proceed through the following instructions.

Instructions

The user is first asked to enter a list of instructions that will draw a new path. One possible list is the one previously mentioned:

```
FD 30 RT 60 FD 30 LT 120 FD 30 RT 60 FD 30
```

Can't see the path? What is the pen state?

When drawing paths, use only the commands FD, RT, LT, PU, and PD.

Reviewing Your Path

If you wish to see the commands that you have entered, you can type

```
SHOW :LIST
```

in the Command Center.

The MOVE Command

When you have entered the instructions for drawing a path—after typing START—you can use the procedure called MOVE to draw the path.

Using the path described above, typing

```
MOVE 1 20
```

draws the path 20 units long.

Typing

```
MOVE 2 50
```

draws the second level of the path 50 units long.

Typing

```
MOVE 3 80
```

draws the third level of the path 80 units long.

Typing

```
MOVE 4 100
```

draws the fourth level of the path 100 units long.

Note that you most likely will want to use the CG (clear graphics) command to clear the page between drawing paths. You also may want to use HT to hide the turtle.

When you are using the MOVE command, there are several things you must keep in mind.

1. Your path is replacing a line segment. Your path must not end where you started.
2. If any segment of your path is longer than the length of the original line segment that you are replacing, the design will rapidly grow off the page.
3. The path you draw need not be connected. The use of the PU and PD commands gives some interesting results. The fractal below is obtained by typing

```
FD 30 RT 90 FD 30 PU LT 90 FD 14 PD LT 90
FD 30 RT 90 FD 30
```

Remember that you must restart the program to enter a new fractal description.

MOVE 1 100 MOVE 2 100 MOVE 3 100

4. The procedure MOVE takes two inputs. The first input is the "level" of your drawing. The second is the length of the drawing. That is, if you are replacing the line segment AB, then the second input to MOVE scales your path so that its endpoints match those of AB.

The MOVE Command and Logo Commands

The MOVE command can be used with other Logo commands. If, for example, your path is the one listed in the introduction to this chapter, then

```
CG
REPEAT 3 [MOVE 3 60 RT 120]
```

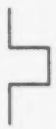
draws the following snowflake design.

Here are some other examples. Remember that you must type START to enter a new path.

If you enter the path

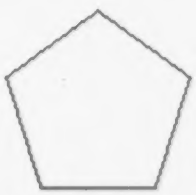
```
FD 30 RT 90 FD 20 LT 90 FD 30 LT 90 FD 20 RT 90
   FD 30
```

you see



Then type

```
CG
LT 90
REPEAT 5 [FD 50 RT 72]
```



Then type

```
CG
LT 90
REPEAT 5 [MOVE 1 50 RT 72]
```

and, then

```
CG
LT 90
REPEAT 5[MOVE 3 50 RT 72]
```

Stopping the MOVE Procedure

It is possible to create a fractal design that will take a very long time to draw. In that case, you may want to use the stop key to interrupt the drawing. You can then type either START and press Return/Enter to begin again, or use MOVE with different input values.

Activities

Activity 1: Exploration

Create and print fractal designs. Describe on the printed copy how you made the design. Share your work with a friend.

Activity 2: Exploring the Number of Lines in a Fractal Design

If a path from A to B is made up of p segments then, at level n, the path from A to B will consist of p^n segments.

For example, the design in Activity 1 is made up of five segments. At level 4, the fractal design from A to B would be made up of 5^4 or 625 segments.

Use the MOVE procedure to explore this idea.

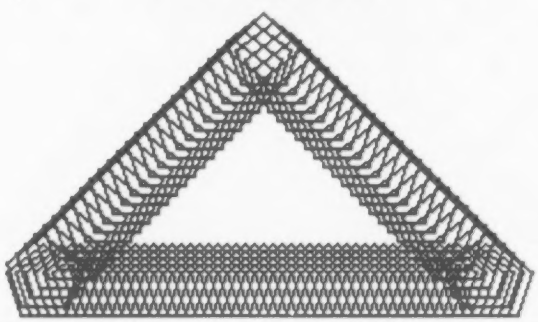
Activity 3: Perimeter of a Fractal

A path design is greater in total length than the length of segment AB. If the total length of a path is p then the limit of p as n tends to infinity is infinity. This suggests that a fractal design can enclose a finite area and yet have an infinite perimeter. Can you use the MOVE procedure to help you think about this idea?

Chapter 11. Translation Designs

Summary

Filename: TDESIGNS
Grade Level: J/I
Color: Optional



The set of small programs in this chapter are designed for students to use in the exploration of the translation of a number of different geometrical designs. By combining the shape procedures and the translation procedures, a wide variety of geometrical designs can be created.

Getting Started

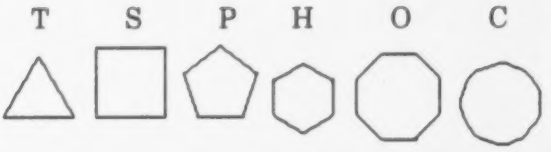
1. Get the page TDESIGNS.
2. Use the commands described in the following instructions.

Be sure to press Return / Enter after entering each of the commands.

Instructions

Shape Commands (T, S, P, H, O, and C Keys)

Use the T key to draw a triangle, the S key to draw a square, the P key to draw a pentagon, the H key to draw a hexagon, the O key to draw an octagon, and the C key to draw a circle.



Simple Translation Commands (U, D, R, and L Keys)

The U key moves the cursor 2 units up the page. The R key moves 2 units to the right; the L key moves 2 units to the left, and the D key moves 2 units down the page. These four commands can be used to translate any of the shapes that the student wishes to draw.

The Translation Command (TRANS, HT, and K Key)

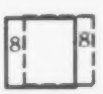
The TRANS command requires two inputs. The first input is the number of units to translate to the right while the second input is the number of units to translate up. For example,

```
TRANS 20 30
```

moves 20 units to the right and 30 units up. You can use the K key to clear the screen and HT to hide the turtle if you wish.

Examples

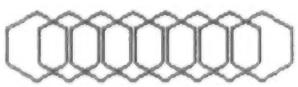
S R R R R S draws a square, moves 8 units to the right (4 twos), and draws a second square.



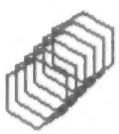
T U U U T draws a triangle, moves up 6 units (3 twos), and draws a second triangle.

H R R R R R R R gives

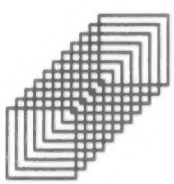
H R R R R R R R repeated eight times gives



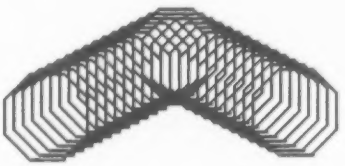
H U U R R repeated six times (REPEAT 6 [H U U R R]) produces:



S R R U U repeated eleven times gives:



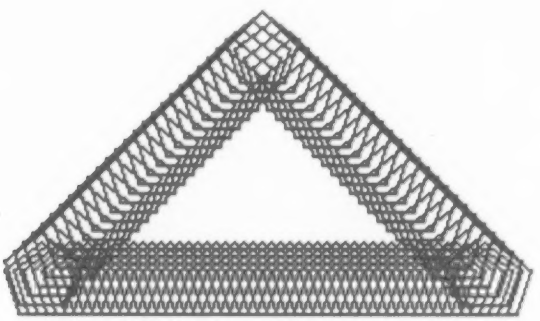
Two patterns of instructions repeated several times—O U R R and O D R R—produce:



Three sets of instructions, P U U R R for the left side, P D D R R on the right and P L L on the bottom are repeated a number of times each. If you enter

```
REPEAT 25 [P U U R R]
REPEAT 25 [P D D R R]
REPEAT 50 [P L L]
```

this produces:

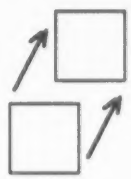


Note that if you want this design to appear on the page without wrapping, you must adjust the start position downward about 20 steps.

Entering

```
S
TRANS 20 40
S
```

draws a square, then moves it 20 units right and 40 units up.



Entering

```
REPEAT 5 [O TRANS 5 -5]
```

moves an octagon 5 units to the right and 5 units down, and repeats the process 5 times.

Activities

Activity 1: Using U, D, R, L

Use all but the TRANS procedure to create and print translation designs. Below your design write how you made it.

Activity 2: Translating Your Own Shape

Write a procedure that will draw some simple shape, for example, a block letter. Write the procedure so that the turtle ends in the same position it started from and points the original direction. Use *your* shape-drawing procedure and the U, D, R, and L keys to create translation designs.

Activity 3: Using TRANS

Repeat activities 1 and 2 and create some translation designs. Use the TRANS procedure instead of the U, D, R, or L keys.

Activity 4: Making Arrays of Shapes

Use the procedures in the file to write a new procedure that will draw five rows of six hexagons. Use this procedure to create overlapping array designs. Repeat for other groups of shapes.

Key Summary for TDESIGNS

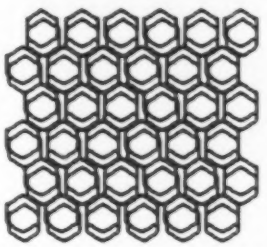
T	Draws a triangle
S	Draws a square
P	Draws a pentagon
H	Draws a hexagon
O	Draws an octagon
C	Draws a circle
U L R D	Move turtle 2 units in the specified direction
TRANS	Translates shapes; requires number of units to translate to the right and number of units to translate up, e.g., TRANS 20 30
K	Clears the graphics from the page and returns the turtle to the home position
HT	Hides the turtle
ST	Shows the turtle
	To print the graphics and text as they appear on the screen, quit the program, type PRINTSCREEN, and then press Return/Enter

Chapter 12. Designs From Overlapping Arrays

Summary

Filename: NEWPAGE
Grade Level: I
Color: Optional

This chapter requires some use of programming. The user needs to be familiar with Logo commands and with flipping the page.

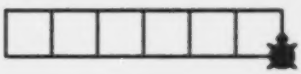


The program TARTAN in Chapter 6 created designs by overlapping lines and threads. You also can use overlapping patterns in other types of arrays. For example, the student could write a procedure to draw a square:

```
TO SQUARE
REPEAT 4[FD 20 RT 90]
END
```

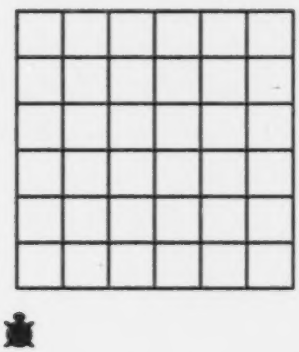
And then use the procedure SQUARE to write a LOGO procedure to draw a line of squares.

```
TO LINE
REPEAT 6 [SQUARE SETX XCOR + 20]
END
```



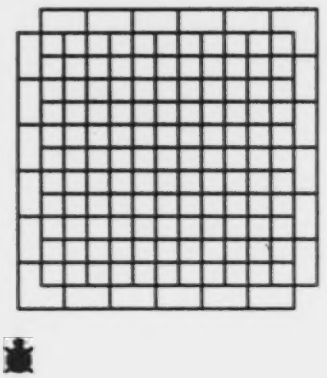
And then use the procedure LINE to draw an array of squares.

```
TO ARRAY
REPEAT 6
   [PD LINE PU SETX XCOR-120 SETY YCOR-20]
END
```

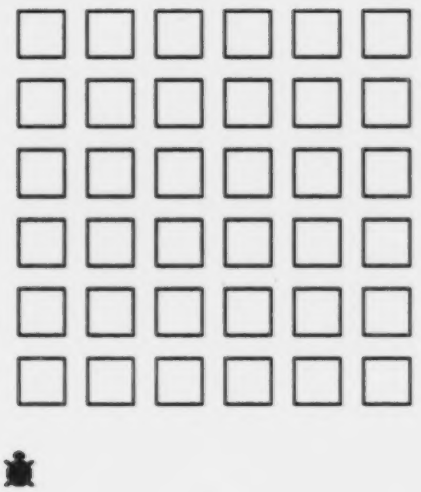


Note that because of the height of the grid, if you would like your page to appear as in the illustration you must adjust the start point up about 20 steps, so the turtle doesn't "wrap" to the bottom of the page.

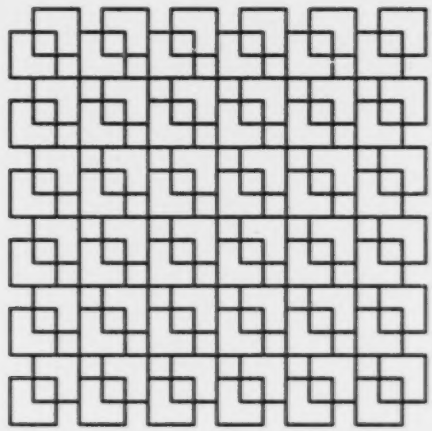
The procedure ARRAY could be drawn once, a new starting point selected and the array drawn a second time overlapping the first array.



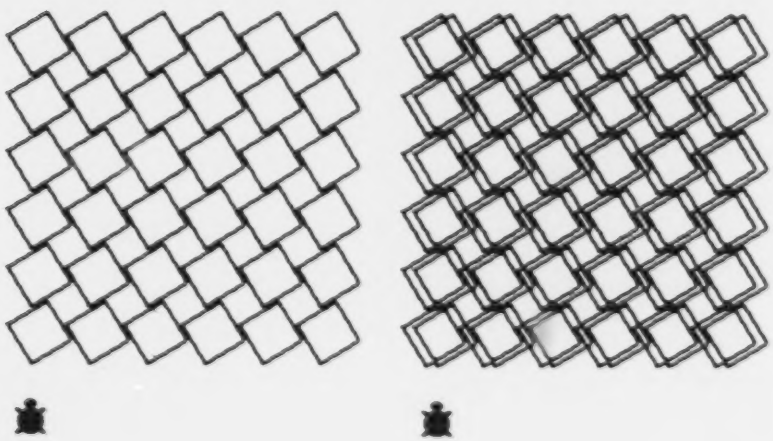
The array of squares, or whatever shape is chosen, need not have touched, for example,



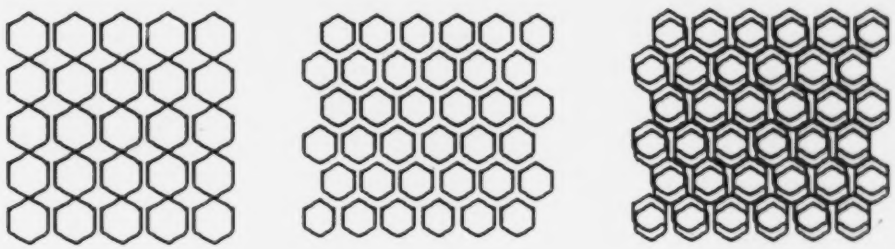
Overlapped arrays of squares that are not touching give rise to different designs depending on how they are aligned. For example,



The arrays need not be oriented at right angles to the page. They can involve turns, for example,



The figure repeated in the array need not have been a square. For example, here are some arrays of hexagons.



Activities

Activity 1: Designs Using Arrays of Squares

Use the procedures above to create new designs of overlapping arrays of squares.

Activity 2: Designs From a Second Array of Squares

Write a procedure that will draw a different array of squares. Use this procedure to create several new designs.

Activity 3: Designs From Arrays of Polygons

Write a procedure that will draw some shape other than a square. Write a procedure that will draw an array of these shapes. Make an array by overlapping two or more arrays of this shape.

Activity 4: Overlapping Arrays Using Rotations

Repeat Activities 3 and 4 but use rotations in making your arrays.

Appendix A
Summary of *LogoWriter* Keys for the Apple IIe/IIc

General Purpose Keys

Flip	Apple-F
Up	Apple-U
Down	Apple-D
Quit, leave page	Esc
Stop	Apple-S
Help	Apple-0

Word-Processing Keys

Select	Apple-1
Cut	Apple-2
Copy	Apple-3
Paste	Apple-4
Erase to End of Line	Apple-6
Next Screen	Apple —>
Previous Screen	Apple <—
Top of Page	Apple-Up Arrow
Bottom of Page	Apple-Down Arrow
Beginning of Line	Apple-B
End of Line	Apple-E
Open a Line	Apple-O
Delete Right	Control-D

Shapes Page Keys

Quit, leave page	Esc
Flip	Apple-F

On the flip side of the page only:

Next Screen (Next Shape)	Apple —>
Previous Screen (Previous Shape)	Apple <—
Up, Down, Left, Right	Arrow keys
Cut	Apple-2
Copy	Apple-3
Paste	Apple-4
Make or Erase Block	Space Bar

Graphics Keys

Turtle-Move	Apple-9
Label	Apple-8
Leave Label or Turtle-Move	Esc

Contents Keys

Top of Page	Apple-Up Arrow
Bottom of Page	Apple-Down Arrow
Remove a Page (Erase to End of Line)	Apple-6

Summary of the *LogoWriter* Keys for the IBM

General Purpose Keys

Flip	Control-F
Up	Control-U
Down	Control-D
Quit, leave page	Esc
Stop	Control-Break
Help	Fn-0

Word-Processing Keys

Select	Fn-1
Cut	Fn-2
Copy	Fn-3
Paste	Fn-4
Erase to End of Line	Fn-6
Next Screen	PgDn
Previous Screen	PgUp
Top of Page	Home
Bottom of Page	End
Beginning of Line	Control <—
End of Line	Control —>
Open a Line	Insert

Shapes Page Keys

Quit, leave page	Esc
Flip	Control-F

On the flip side of the page only:

Next Screen (Next Shape)	PgDn
Previous Screen (Previous Shape)	PgUp
Up, Down, Left, Right	Arrow keys
Cut	Fn-2
Copy	Fn-3
Paste	Fn-4
Make or Erase Block	Space Bar

Graphics Keys

Turtle-Move	Fn-9
Label	Fn-8
Leave Label or Turtle-Move	Esc

Contents Keys

Top of Page	Home
Bottom of Page	End
Remove a Page (Erase to End of Line)	Fn-6

Summary of *LogoWriter* Keys for the Macintosh

General Purpose Keys

Flip	⌘-F
Up	⌘-U
Down.	⌘-D
Quit, leave page	Esc, Clear, or ⌘-Shift
Stop	⌘-.

Word-Processing Keys

Select	⌘-1
Cut	⌘-2 or ⌘-X
Copy	⌘-3 or ⌘-C
Paste	⌘-4 or ⌘-V
Erase to End of Line	⌘-6
Next Screen	⌘—>
Previous Screen	⌘<—
Top of Page	⌘-Up Arrow
Bottom of Page	⌘-Down Arrow
Beginning of Line	⌘-B
End of Line	⌘-E
Open a Line	⌘-O

Shapes Page Keys

Quit, leave page	Esc
Flip	⌘-F

On the flip side of the page only:

Cut	⌘-2 or ⌘-X
Copy	⌘-3 or ⌘-C
Paste	⌘-4 or ⌘-V

Graphics Keys

Turtle-Move	⌘-9
Label	⌘-8
Leave Label or Turtle-Move	Esc

Appendix B
Quick Reference

LogoWriter Primitives and Special Words

* Primitive is a reporter (operator).
\# Primitive is either a command or a reporter.

Screen
- CC—Clear Command center
- CG—Clear Graphics
- CP—Clear Page
- CT—Clear Text

Scrapbook
- CLEARTOOLS
- CONTENTS
- DOS (IBM only)
- ERPAGE *pagename*—ERase Page
- FLIP
- * FRONT?
- GETPAGE (GP) *pagename*
- GETSHAPES *pagename* (Mac Only)
- GETSOMESHAPES *pagename list* (Mac Only)
- GETTOOLS *pagename*
- LEAVEPAGE
- LOAD *pagename*
- LOCK (Mac only)
- NAMEPAGE (NP) *pagename*
- NEWPAGE
- * PAGELIST
- RESTORE
- SAVEPAGE
- SHAPES
- * TOOLLIST
- UNDO (IBM and Apple only)
- UNLOCK

Workspace
- RECYCLE
- * SPACE

Timing
- CLOCK (Mac Only)
- RESET (Mac Only)
- TIMER (Mac Only)
- WAIT *number*

Sound
- ERSOUND *name* (Mac Only)
- PLAY *name* (Mac Only)
- RECORD *name number* (Mac Only)
- SOUNDLIST (Mac Only)
- TONE *frequency time*

Input/Output
- * BUTTON? *button number* (Mac—no input)
- CLEARCOM (Mac Only)
- * KEY?
- PADDLE *number* (IBM and Apple only)
- * READCHAR (Mac only)
- * READLIST (RL)
- * READLISTCC (RLCC)
- RECEIVECHAR (RCCC)
- SEND *word/list* (Mac only)
- SETBAND *number* (Mac only)
- SETCF *word1 word2* (Mac only)

Assigning
- CLEARNAME *word/list*
- CLEARNAMES
- MAKE *name word/list*
- NAME *word/list name*
- * NAME? *word*
- PRINTNAMES
- SHOWNAMES
- THING *names*

Printer Commands
- DSPACE—Double SPACE (IBM and Apple only)
- PRINTSCREEN
- PRINTTEXT
- PRINTTEXT80 (IBM and Apple only)
- SSPACE—Single SPACE (IBM and Apple only)

Special Words
END
FALSE
HELP *pagename* (Mac only)
STARTUP
TO
TRUE

System Modifying Primitives (IBM/Apple)
.BLOAD *name/pathname address*
.BSAVE *name/pathname address length*
.CALL *address*
.DEPOSIT *address byte*
* .EXAMINE *address*

Flow of Control/Logic
* AND *true/false1 true/false2*
CAREFULLY *list1 list2*
ERRORMESSAGE (Mac Only)
ERRORNUMBER (Mac Only)
* IF *true/false list to run*
# IFELSE *true/false list.to.run1 list.to.run2*
LOCAL *word/list* (Mac Only)
* NOT *true/false*
* OR *true/false1 true/false2*
OUTPUT (OP) *word/list*
REPEAT *number list.to.run*
RUN *list.to.run*
STOP
STOPALL

Math (Note: all are reporters)
\+ - * / (Mac only)
> < =
<> <= >= \ ^
ABS *number* (Mac only)
ARCTAN *number*
COS *degrees*
DIFFERENCE *number1 number2* (Mac Only)
E (Mac Only)
EXP *number* (Mac Only)
GREATER? *number1 number2* (Mac Only)
INT *number*
LESS? *number1 number2* (Mac Only)
LN *number* (Mac Only)
LOG *number1 number2* (Mac Only)
PI (Mac Only)
POWER *number1 number2* (Mac Only)
PRODUCT *number1 number2* (Mac Only)
QUOTIENT *number1 number2* (Mac Only)
RERANDOM (Mac Only)
RANDOM *number*
ROUND *number*
SETNF *number* (Mac Only)
SETPOINT (Mac Only)
SETCOMMA (Mac Only)
SIN *degrees*
SQRT *number*
SUM *number1 number2* (Mac Only)
TAN *number*

Events
CLEAREVENTS
PRINTEVENTS (Mac Only)
SHOWEVENTS (Mac Only)
WHEN *letter list.to.run*

Graphics
* ALL
# ASK *turtle/turtle.list list.to.run*
BACK (BK) *number*
* BG
CHANGECOLOR *number list of three numbers* (GS)
* CHARUNDER - CHARacter UNDER
CLEAN
* COLOR
* COLORUNDER
* COLORVALUE *number* (GS)
* CURSORPOS
* DISTANCE *list of two numbers* (GS/IBM/Mac)
EACH *list.to.run*
FASTTURTLE (GS/Mac)
FILL
FORWARD (FD) *number*
HEADING
HOME
HT—Hide Turtle
LABEL *word/list*
LEFT (LT) *number*
MOUSEPOS (Mac Only)
PD—Pen Down
PE—Pen Erase
* POS
PU—Pen Up
PX—Pen Reverse
RESETCOLORS (GS)
RG—Reset Graphics
RIGHT (RT) *number*
SETBG *number*
SETC *number*
SETH *number*
SETPOS *[x y]*

SETSH *number*
SETX *number*
SETY *number*
SHADE
* SHAPE
SLOWTURTLE (GS/Mac)
ST—Show Turtle
STAMP
TELL *turtle / turtle.list*
TOUCHING? (Mac Only)
* TOWARDS *list*
* WHO
WINDOW
WRAP
XCOR
YCOR

Text Editing/Words and Lists

* ASCII *char*
BOTTOM
* BUTFIRST (BF) *word / list*
* BUTLAST (BL) *word / list*
CB—Cursor Back
CD—Cursor Down
CF—Cursor Forward
* CHAR
* CLIPBOARD
COPY
* COUNT
CU—Cursor Up
CURSORCHAR
CUT
DELETE
* EMPTY? *word / list*
EOL
* EQUAL? *word / list1 word / list2*
* FIRST *word / list*
* FOUND?
* FPUT *word / list list*
* IDENTICAL? *word / list1 word / list2*
INSERT *word / list*
* ITEM *number word / list*
* LAST *word / list*
* LIST *word / list1 word / list2*
* LIST? *word / list*
* LPUT *word / list list*
* MEMBER? *word / list1 word / list2*
NEXTSCREEN
* NUMBER?
PARSE *word*
PASTE
PRESCREEN
PRINT (PR) *word / list*
REPLACE *word1 word2*
SEARCH *word*
SELECT
* SELECTED
* SENTENCE (SE) *word / list1 word / list2*
SETEXTPOS *number*
SETTC *number* (GS)
SHOW *word / list*
SOL—Start Of Line
TAB
* TC (GS)
* TEXTLEN
* TEXTPOS
TOP3
TYPE *word / list*
UNSELECT
* WORD *word1 word2*
* WORD? *word / list*

Disk (Apple or IBM)

* DISK
SETDISK *letter*

ProDos Primitives

BYE
COPYFILE *name / pathname1 name / pathname2*
CREATEDIR *pathname*
* DIRECTORIES
DISK (Mac only)
ERASEFILE *name / pathname*
* FILELIST
LOADPIC *name / pathname*
LOADTEXT *name / pathname*
* ONLINE
* PREFIX
RENAME *name / pathname1 name / pathname2*
SAVEPIC *name / pathname*
SAVETEXT *name / path*
SETDISK *word*
SETPREFIX *pathname*
SETSLOT
* SLOT
* .VERSION

IBM DOS Primitives

CHDIR *name / pathname*
COPYFILE *name / pathname1 name / pathname2*
* CURRENTDIR
* DIRECTORIES
DISK
DOS

ERASEFILE *name / pathname*
* FILELIST
LOADPIC *name / pathname*
LOADTEXT *name / pathname*
MKDIR *pathname*
RENAME *name / pathname1 name / pathname2*
RMDIR
SAVEPIC *name / pathname*
SAVETEXT *name / pathname*
SETDISK *word*
* .VERSION

Macintosh Primitives

COPYFILE *name / pathname1 name / pathname2*
CREATEDIR *pathname*
* DIRECTIONS
* DISKSPACE
ERASEFILE *filename*
* FILELIST
LOADPIC *filename / pagename*
LOADTEXT *filename / pagename*
* ONLINE
PAGE
* PREFIX
QUIT
RENAME *name / pathname1 name / pathname2*
RMDIR *name*
SAVEPIC *name / pathname*
SAVETEXT *filename*
.VERSION

Appendix C
Additional Primitives for the Macintosh

Math Primitives

number/ \number
\ is the equivalent of REMAINDER

ABS *number*
ABS reports the absolute value of its input.

DIFFERENCE *number1 number2*
DIFFERENCE is the prefix form of the subtraction sign (-). It takes two numbers as input and reports the result of subtracting the second input from the first one.

E
Reports the value of the transcendental number e.

EXP *number*
EXP takes one number as input. It reports the number e raised to the power of the input to EXP. This is the inverse of LN.

LN *number*
LN reports the natural logarithm of its input. This is the inverse of EXP.

LOG *number (or number1 number2)*
LOG reports the logarithm of its input in base 10.

PI
Reports the value of π.

POWER *number1 number2*
Reports the value of the first input raised to the second input.

PRODUCT *number1 number2*
This is the prefix form of the multiplication sign (*). It reports the product of its two inputs.

QUOTIENT *number1 number2*
QUOTIENT reports the result of dividing the first input by the second input. Division by zero gives an error. This is the prefix form of the division sign (/).

SETNF *number*
This primitive takes one input and sets the number of digits displayed after the decimal point. The default is for *LogoWriter* to display 4 digits. SETNF does not affect the precision of Macintosh *LogoWriter*. It always uses 16 digits for

computations. Macintosh *LogoWriter* can also display numbers in scientific notation. For example 1.0E10 means 10^{10}.

SETPOINT
Causes LogoWriter to use a decimal to separate the integer part from the fractional part of a number.

SETCOMMA
Causes LogoWriter to use a comma to separate the integer part from the fractional part of a number.

SUM *number1 number2*
This is the prefix form of the addition sign (+). It reports the sum of the two input numbers.

TAN *number*
TAN reports the tangent of its input in degrees.

Flow of Control and Logic

CAREFULLY *list1 list2*
CAREFULLY takes two lists as inputs. The first input is a list of instructions that is run. If there is an error while this list is running, the second list is run. If there is no error in the first list, the second is ignored and ERRORNUMBER is set to 0 while ERRORMESSAGE is an empty word.

ERRORMESSAGE
This reporter returns the most recent error message.

ERRORNUMBER
This reporter returns the number of the most recent error message.

-H
Pressing this key combination causes the current procedure to pause. Pressing any key causes it to begin again.

Time

CLOCK
This reporter returns a list containing the date and the time in the format [10/19/89 4:30:55 PM]

RESETT
Resets the timer to 0.

TIMER
This primitive reports the duration, in 60ths of a second, since the last RESETT command.

Help

HELP
The HELP primitive allows you to create your own Help page. It takes one input, the name of a page. The page can be looked at but not changed.

Help Menu
Under the Apple Menu at the left edge of the menu bar are two choices for help. The "Help Page..." option gets a page named help. The "Help Primitives..." displays a list of all the primitives in Macintosh *LogoWriter* in alphabetical order. Clicking on one of the primitives in the list causes a description of that primitive to appear.

Sound

ERSOUND *sound*
This command takes the name of a sound resource as input and erases it.

PLAY *sound*
This command takes one input and plays the named sound resource.

RECORD *sound duration*
This command takes two inputs, a name and a number. The first input is the name to be used to save a recorded sound. The second is the number of seconds to be recorded. This command works with Macintosh models with built in microphones.

SOUNDLIST
Reports the list of current sound resources.

Communication

CLEAR COM
Clears the communication line.

RECEIVECHAR, RECC
This reporter returns the character being received through the communication channel. If no character is being received, LogoWriter waits for a character.

SEND *word/list*
This command sends a word or a list through the communication line. It does not send a carriage return following the input.

SETBAUD *number*
This command takes a number as input. This number must be one of the following baud rates: 300, 1200, 2400, 4800, 9600, 19200. The default value is 4800.

SETCF
This command takes two inputs and sets the communication format. The first input is the category; the second input is the value. Here are the possible values:

Miscellaneous

BUTTON?
Reports true if mouse button has been clicked.

MOUSE POS
Returns the position of the mouse in turtle coordinates.

PRIMITIVES
This reports a list of all of the primitives in LogoWriter.

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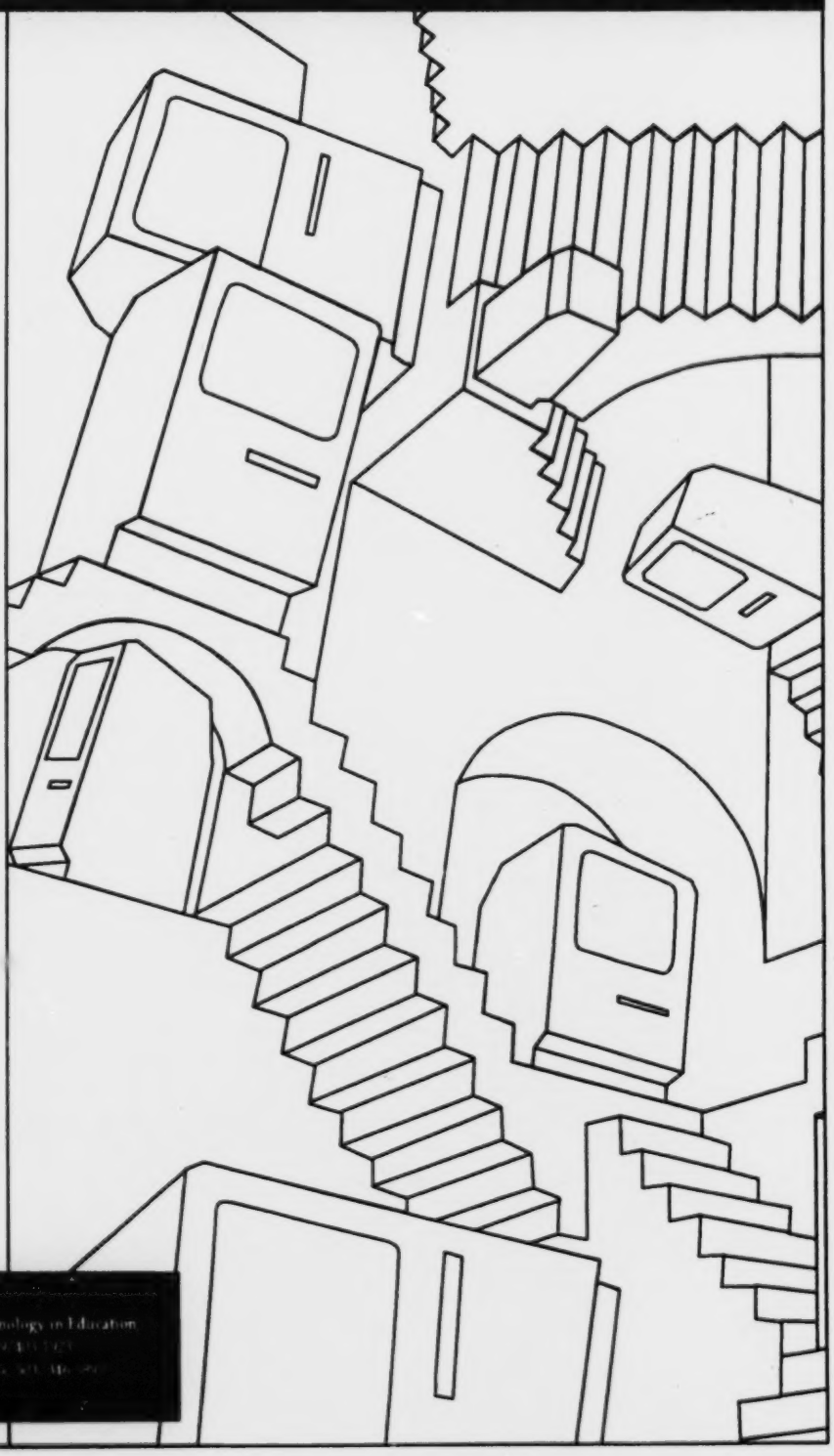

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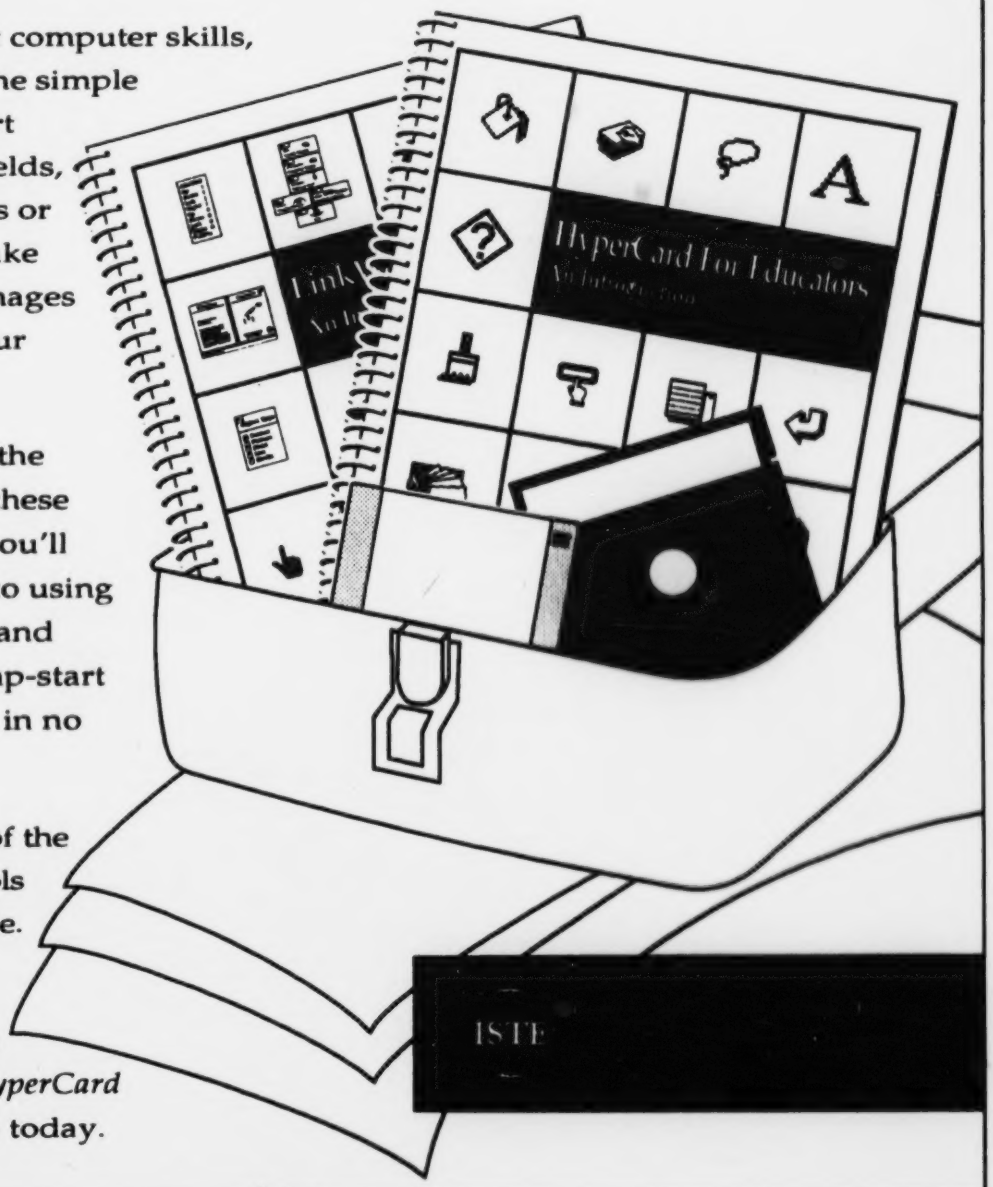
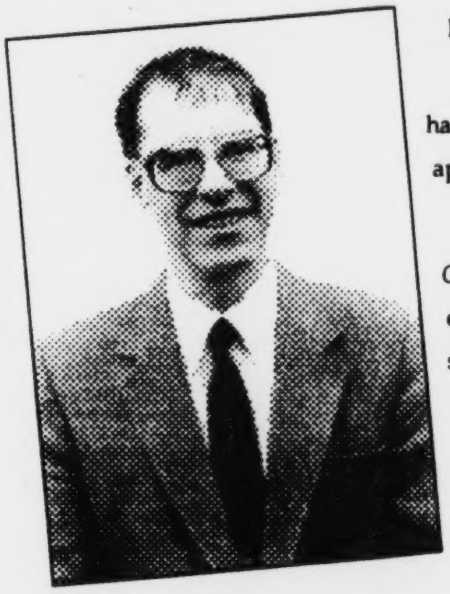


Dave Moursund knows...



ISTE Executive Officer Dave Moursund is dedicated to improving education.

Since he first began working with computers in education in 1963, Dave has constantly sought to improve education at all levels through the use of appropriate computer-related technology.

As a continuing part of this effort, Dave's newest book—*The Technology Coordinator*—discusses the goals of education and how teachers and teachers of teachers can join in the enormous change process facing today's schools.

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In recent years, Dave has focused much of his writing efforts on problem solving and on staff development. Some of Dave's other books also available from ISTE include *Problem-Solving Models for Computer Literacy, LogoWriter for Educators: A Problem Solving Approach, Logo PLUS for Educators: A Problem Solving Approach* (co-authored with Sharon Yoder), and *Effective Inservice for Integrating Computer-as-Tool into the Curriculum.*

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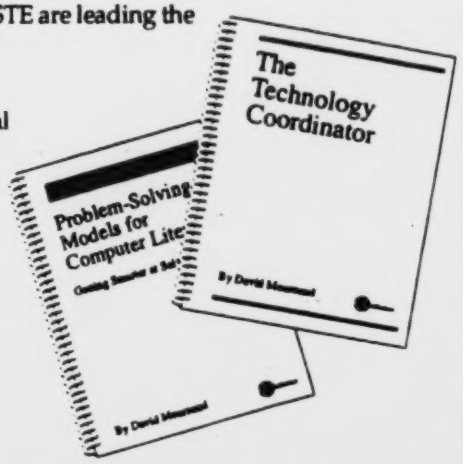

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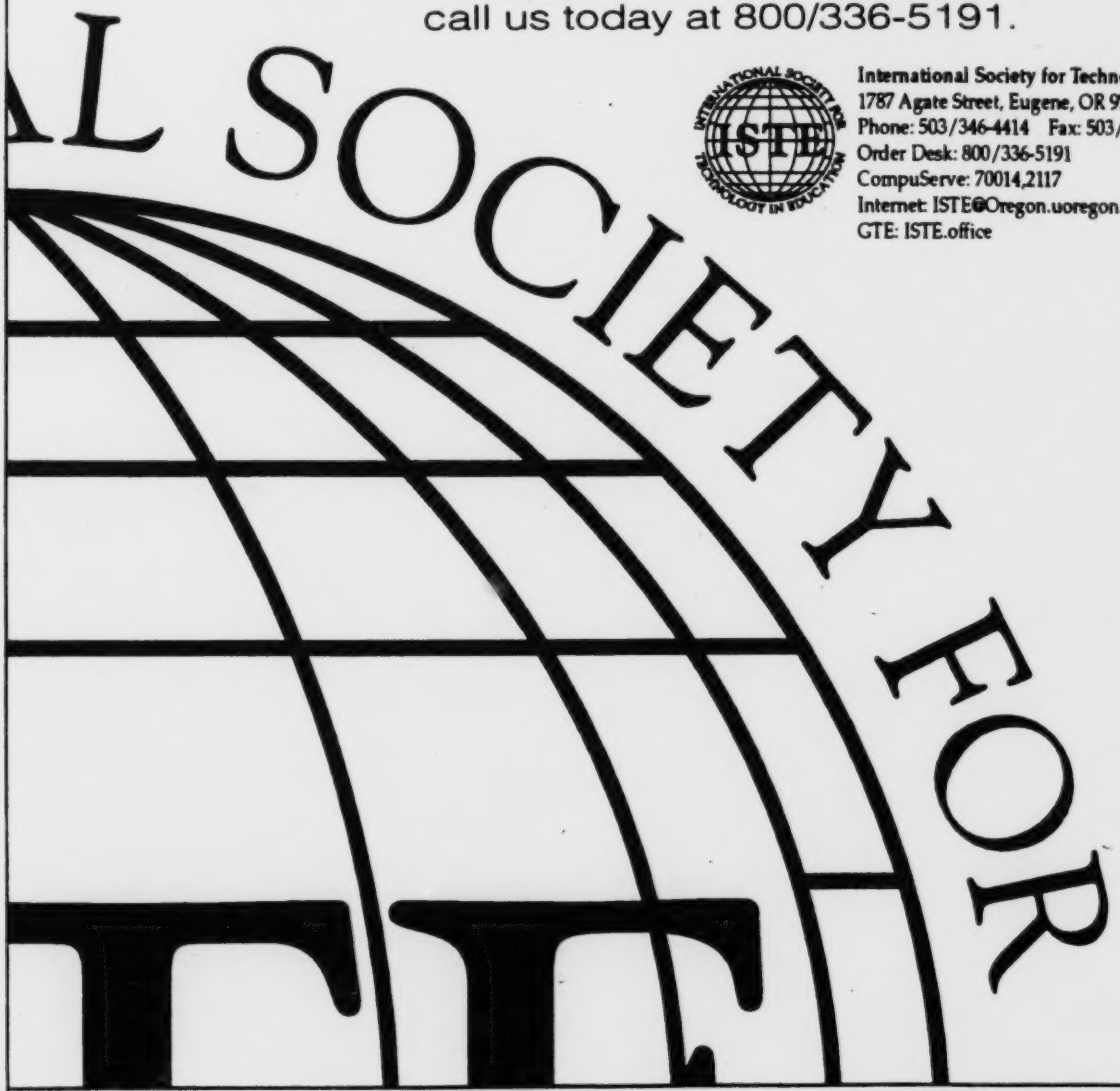

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